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with CHEMICAL & METALLURGICAL ENGINEERING

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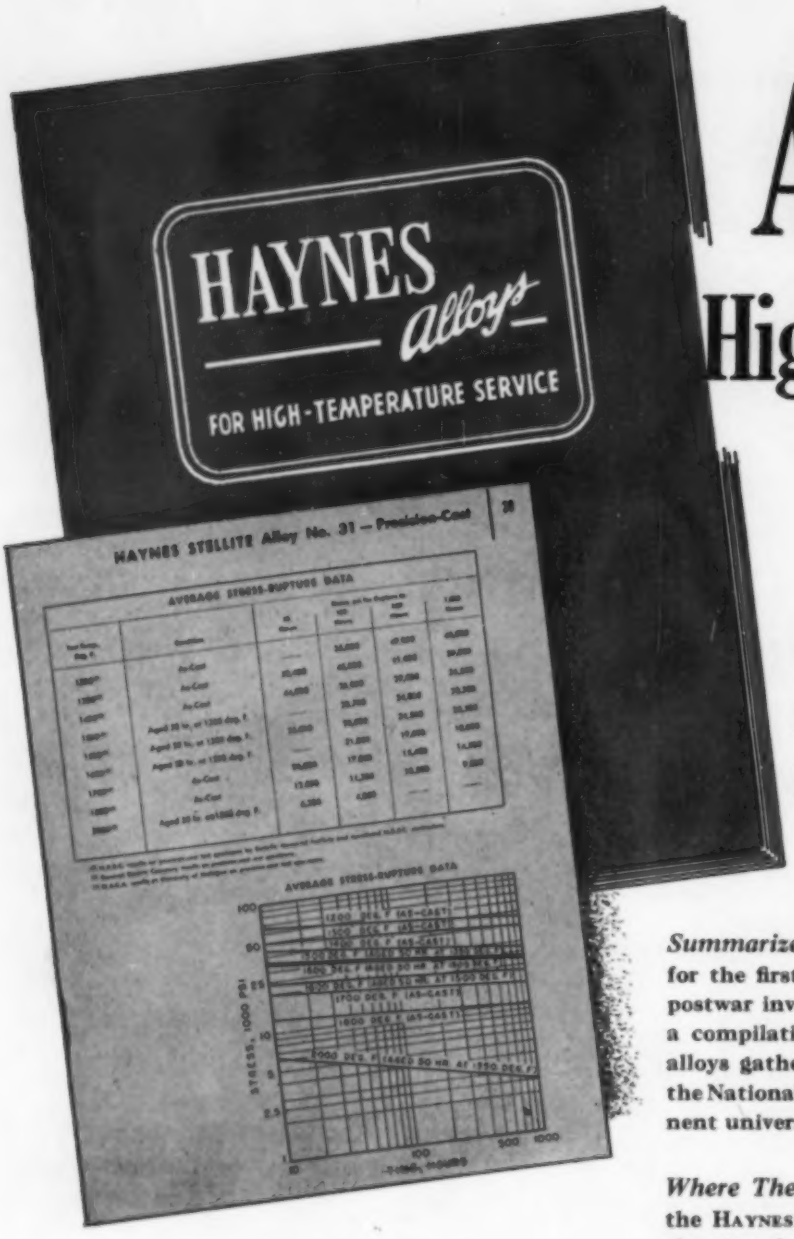

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COMMENTS ON THE NEWS OF CHEMICAL ENGINEERING IN INDUSTRY

Volume 55 MAY • 1948 Number 5

Canada's plastics industry is mushrooming. The dollar volume of plastics production in Canada now is running at a rate more than seven times that of 1939. Near the end of 1947, Dow Chemical of Canada, Ltd., at Sarnia and Monsanto (Canada), Ltd., at Montreal put into operation polystyrene plants. Now Canada's dependence on the United States for polystyrene has almost disappeared. Both of these companies, in fact, are exporting that basic material.

In addition, Bakelite Co. (Canada), Ltd., is building a modern plant at Belleville that will cost more than $2 million. Canadian Resins & Chemicals, Ltd., is building a plant at Shawinigan Falls to turn out vinyl resin plasticizers. Die-Plast Co., Ltd., of Montreal is getting set up to produce single threads of saran for use in weaving saran cloth and plastic insect screens. The manufacturers expect that their exports eventually will be two or three times as large as their domestic sales.

•

European recovery requirements are being appraised by ECA. For the first year, here are estimated dollar values of some commodities Europe will get: steel, $95.7 million; copper, $85.6 million; lead, $53.5 million; zinc, $37.4 million; coal, $245.3 million; petroleum products, $379.7 million; chemicals, $166.5 million; phosphates, $1.0 million; nitrogen fertilizers, $20.6 million; cotton, $511.3 million; fats and oils, $131.9 million; and oil cake and meal, $60.2 million. How much of these commodities will come from the United States and how much from other Western Hemisphere sources has not been indicated. Current goal of ECA is a quick 30 percent increase in European production.

•

Voluntary commodity allocations are not working out as expected. Department of Commerce is being asked for allocation programs by industries it would rather did not have them; it is getting refusals from those industries in which the government would like to put allocation programs in operation.

How big a bite will the petroleum industry take from U. S. steel production? A voluntary agreement among the steel makers may decide the tonnage allocated. To boost petroleum production about 5 percent, the oil industry has asked for 15 million tons of steel in the 18-month period that began April 1. But David K. Bruce, Assistant Secretary of Commerce, told a congressional committee investigating petroleum and steel shortages he was not convinced that the oil industry needs that much steel.

Faced with a tight supply situation and already doing all they could to increase output, the nitrogen producers saw little advantage in the Commerce invitation. The law does not require acceptance. So the nitrogen producers decided not to name an industry advisory committee. Unless they change their minds, no further action can be taken.

Manufacturers of caustic soda and soda ash, on the other hand, did appoint an advisory committee. Meeting in New York City in April, the committee drafted a tentative schedule of export allocations to submit to producers. Alkali manufacturers, the committee agreed, will continue to make supplies available through normal distribution channels.

•

Military stockpilers are seeking priorities or end-use controls over strategic materials. The stockpilers have won large appropriations to put more materials on the shelf this coming year. What the military wants ready for use on a moment's notice (on the books, preferably, to be brought into force by a directive from the President) is machinery to police end-use of these materials. Munitions would get top priority, with stockpiling and civilian industry, in that order, following. The armament program would have to balloon considerably, however, before such priorities would be voted by Congress. Hence, the military will get materials via dollars, not directives.

Topping the list of strategic materials in Group A (items which must be stockpiled for emergency use)

ENGINEERING PROBLEMS IN AGITATION

PART OF A CONTINUING PROGRAM OF ENGINEERING BY MIXING EQUIPMENT CO., FOR THE ADVANCEMENT OF AGITATION

LIGHTNIN MIXCO

Can You Get a 45" Turbine Through a 16" Manhole?

PROBLEM: How to get a large impeller into a pressure vessel through a reasonable size opening of less diameter than the impeller.

EXPLANATION: Just as the umbrella was a cumbersome affair until it was made to fold up, so a large cast impeller is frequently impossible to use economically in a pressure vessel. Either an expensive nozzle has to be provided, or the vessel cut open.

SOLUTION: Mixco Engineers solved this problem by applying the method of blade attachment used in most paddle construction. Thus the method is not radical but generally accepted. The removable blade turbine impeller provides for entry through the smallest possible opening.

EXAMPLE: Given a 45" turbine: with blades removed, the disk will pass through a 31" opening. With the disk split, *it will pass through a 16" opening, ready for assembly (without welding)* inside the tank. The saving in tank fittings, nozzles and assembly time are worthwhile and should amount to more than $500 in a stainless steel pressure vessel. Other features appreciated by hundreds of users are:

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Permits use of composite construction such as low cost alloy for disk, high cost alloy for blades, where abrasion is a serious problem. This important detail in the business end of an agitator has helped many engineers solve problems of an almost impossible nature.

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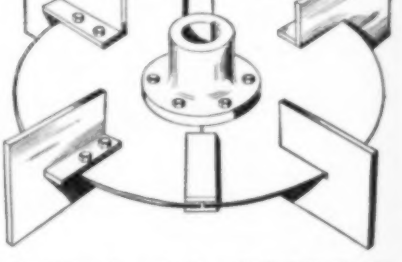

Illustration shows simple method of "splitting" turbine. Disk is made in halves and bolted to the hub. All torque is transmitted by these bolts, the two halves are held at the edges of the disk by two mating clips. For many applications it is not necessary to split the turbine, in which case the disk is furnished in one piece.

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•

Freeze order on war plant sales came too late to have much effect. All but about 300 of the 1,800 properties have been sold. Some of the contracts carried a national security clause, giving the military a chance to get the facilities back in an emergency. But most of the units have been converted to peacetime production.

The President's freeze order, even if extended a few months, will not halt WAA's selling activities. Generally, WAA knows the plants it can and cannot sell. It can still sell any plant if the contract contains a recapture clause. When no recapture clause is included in the deal, WAA can get clearance from the military to go ahead with the sale.

•

Science Foundation legislation may still get through Congress this year. The present bill is not controversial. Critics of last year's bill, including President Truman, who vetoed it because the Foundation would have been independent of the executive branch of the government, are now behind S. 2385, backed by Senator H. Alexander Smith, and its companion bill, H. R. 6007, introduced by Representative Charles A. Wolverton. Both legislators are New Jersey Republicans.

This year's bill provides for appointment of the director of the Foundation by the President, with the advice and consent of the Senate. The director may be removed by the President. Foundation members, 24 in all, are also appointed by the President. Other changes: the Foundation would be authorized to "develop and encourage" a national policy for promotion of fundamental research and scientific education, but not to "establish" such a policy, as provided by last year's bill; the director, with the approval of the Foundation, would award the scholarships and fellowships, instead of the Foundation itself having authority to make the awards. Just how military research would fit into this program and what would happen to the Interdepartmental Committee on Research and Development remain obscure.

•

Importance of technical manpower is stressed by leading industrial scientists who are following closely the revived selective service legislation now before Congress. When he appeared before it, Dr. Charles A. Thomas, ACS president, told the House Armed Services Committee that Russia has already embarked on a five-year plan to step up scientific training.

Thomas, who is also executive vice president of Monsanto and former head of the Clinton Laboratories at Oak Ridge, Tenn., warned against repetition of the tragic blunders of World War II, when technical workers and students were drafted indiscriminately. "Science and technology," Thomas said, "are essential to national survival."

While he does not favor providing "draft havens" for any groups, Thomas made the following specific recommendations: (1) deferment of scientists and technologists fully utilized in essential work in industry, government and military establishments; (2) deferment of university scientists engaged in teaching and research; (3) deferment of promising scientific and engineering students under a limited quota; and (4) creation of a national scientific appeal board, consisting of civilians with recognized scientific background, to decide all appeals for deferment of scientists and technologists within the legal criteria.

Unless the scientific and engineering talent of the nation is conserved and developed, Thomas warned, the armed forces will deteriorate, national security will be lost and "the stability of the peace structure will fall."

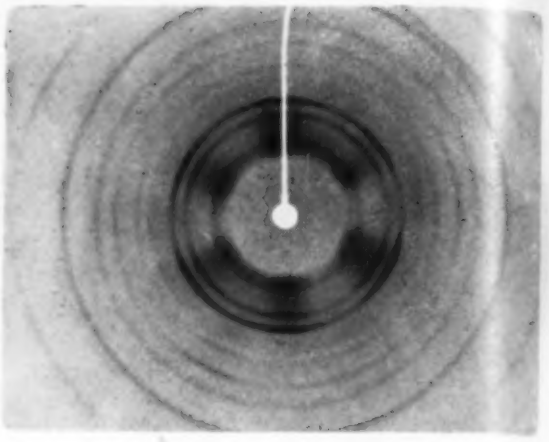
At present, however, draft legislation on Capitol Hill provides no special consideration for scientists. Draft bill now will repeat, from the point of view of the scientists, the same mistakes of World War II. It will be the old battle for individual deferments all over again. Already the American Council on Education has advocated national and special control of scientific manpower as a way to give the problem the serious attention it deserves. Association of Land Grant Colleges is thinking along the same lines.

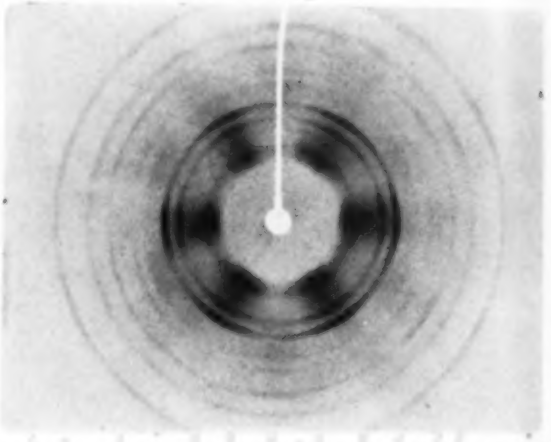
•

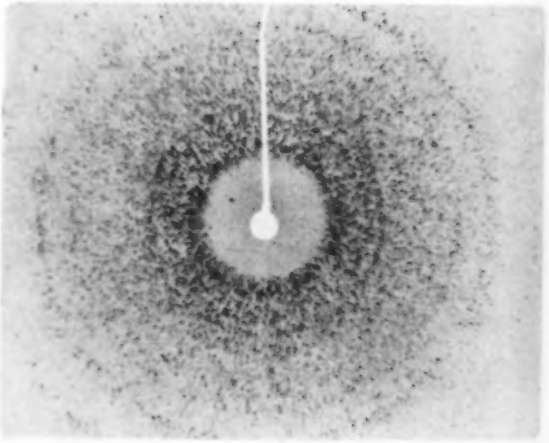
Plan for sale of stock in Wyandotte Chemicals Corp. to Solvay American Corp. has been approved

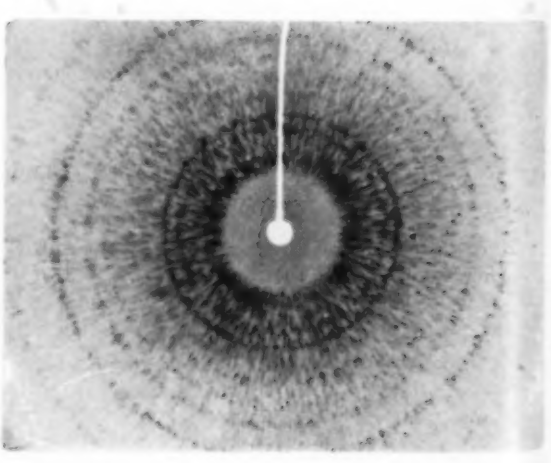
(*Continued on page 76*)

PICTURE OF A TUBE









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(*Continued from page 73*)

by Wyandotte stockholders. Initially, Solvay American will invest $12,750,000 in new Wyandotte stock. Later stock purchases by Solvay will bring its total investment in Wyandotte to about $18 million, still a minority holding.

When Solvay offered to purchase the stock, Wyandotte was in the market for working capital. It also has a $25 million expansion program to finance. The Solvay purchase offer looked like the best bet, so Wyandotte stockholders accepted it. Their only motive: to acquire added capital.

Control of Wyandotte will remain in the hands of present owners. The Wyandotte management has scotched talk of sales agreements, division of sales territories and mapping of markets. It emphasizes the investment character of Solvay's share holdings in Wyandotte.

The Solvay interests have disposed of part of their Allied Chemical & Dye Corp. holdings and the remaining shares will go into a voting trust. Thus Solvay will have no voting interest or representation in Allied. Solvay American Corp. is the American affiliate of Solvay et Cie. of Brussels, Belgium.

•

On the chemical labor front there was less unrest last year. Strikes in the chemical and allied products industry declined during 1947, as they did in most other industries. Here is how last year compared with 1946: the number of strikes fell from 122 to 94; workers involved dropped from 48,100 to 30,800; and man-days of idleness decreased from 1,190,000 to 439,000.

•

Hours and earnings statistics continue to show the chemical industry above the average of all manufacturing in weekly earnings, weekly hours and hourly earnings. Employees in the chemical and allied products industry worked during January, for example, 41.5 hr. a week at $1.31 an hr., earning an average of $54.38 a week. The corresponding averages for the all-manufacturing group were 40.5 hr., $1.29 an hr. and $52.17 a week.

•

All-out battle against communism within the union is being waged by the leadership of the United Gas, Coke and Chemical Workers, CIO. In upstate New York, Martin Wagner, president of the union, has fired two left-wing officials accused of undermining the union. Vice president Charles A. Doyle of Buffalo, N. Y., faces possible deportation as an alien Communist. District conventions of the union in Cleveland, Ohio, and Newark, N. J., have taken stands against Wagner and threaten to oppose his reelection this summer. The same fight rages within the whole CIO, with president Philip Murray and his supporters openly attacking the Communists for the first time.

A particularly hot situation has developed at the Solvay Process Division of Allied Chemical & Dye Corp. in Detroit, Mich. Officials of the local CIO union there were suspended by Wagner and joined the United Mine Workers, District 50. The leaders who went to District 50 then petitioned the National Labor Relations Board for an election to decertify the CIO as bargaining agent for the 825 employees in the bargaining unit. If they succeed, this soda ash plant will be without a union contract. Then District 50, bossed by John L. Lewis, may start trouble. This outfit has not filed non-Communist affidavits, so it cannot get on an NLRB election ballot. It may, however, seek voluntary recognition from the management, striking if necessary.

The split within the ranks of the CIO organization has come over the filing of non-Communist affidavits, the candidacy of Henry Wallace and the Marshall Plan. This rift has intensified inter-union raiding. And it spells trouble for the employer dealing with union leaders whose policies conflict with those of the national CIO.

•

Natural gas and petroleum in the United States, the prophets of doom to the contrary, are still abundant. At the beginning of 1948, proved reserves of natural gas were 166 trillion cubic feet; of petroleum, 24.7 billion barrels. These joint estimates of AGA and API indicate a 3 percent increase in gas and oil known to be underground. Thus discoveries outran consumption for still another year.

•

New formaldehyde plant is being erected by Spencer Chemical Co. on an 80-acre tract near Calumet City, Ill., in the Chicago area. Initial production is planned for late 1948. At Military, Kan., where its anhydrous ammonia plant is located, Spencer Chemical recently completed a methanol unit. Part of this methanol will come by tank cars to the Calumet City plant, where it will be processed with oxygen to make formaldehyde. The new Spencer plant will free manufacturers of plastics in the Chicago area from dependence on formaldehyde from the East.

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"Uranium Rush of '48" may be on this summer. AEC has offered a $10,000 bonus for the discovery

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and production of high-grade uranium ores from any new deposit in the United States. It also has guaranteed for 10 years minimum prices for domestic refined uranium, high-grade uranium ores and mechanical concentrates. In the Colorado plateau area, AEC has guaranteed for three years minimum prices for carnotite and roscoeite ores. In that area, government operation of two plants (one at Monticello, Utah) to process these uranium and vanadium ores has been assured by AEC. Meanwhile, a 40-sq.-mi. area in Colorado will be drilled this summer in search for uranium, source of fissionable material for A-bombs.

•

Chemical products from kraft mills may in time have greater value than the pulp itself. It takes 4,500 lb. of wood to make one ton of paper. More than half of the original material remains. Here is one of the big raw material fields in industry today. And wood is no worry. An agricultural crop, it can be grown on "tree farms."

Tall oil from kraft mills pulping southern pine is a good example. From an entire United States production of only 10,000 tons in 1937 tall oil recovery has climbed in a decade to a record 1947 output of more than 125,000 tons. Within a few years the growing sulphate pulp industry may recover annually as much as 200,000 tons. A ton of pulp yields from 70 to 90 lb. of crude tall oil. A plant making 1,000 tons of pulp a day can recover from 35 to 45 tons of crude tall oil a day.

Among the big United States producers of tall oil are West Virginia Pulp & Paper Co., National Southern Products Corp., Union Bag & Paper Corp., Newport Industries, Inc., Camp Manufacturing Co. and Gaylord Container Corp.

In kraft pulping, the alkali saponifies the fatty acids and resin acids occurring naturally in the pine. Skimmed off the spent cooking liquor, this soap is cooked with sulphuric acid to get crude tall oil. Refined tall oil is obtained by high-vacuum distillation.

Although it did not come into use in the United States until the middle Thirties, the tall oil recovery process was first developed in Sweden about 30 years ago. Spangenberg Werke, Hamburg-Eidelstadt, which pioneered use of tall oil in Germany, processed about 12,000 metric tons a year during the war. In Germany tall oil was used as a substitute for linseed oil and resin in the protective coating and linoleum industries. Tall oil distillate was used to make stand oil-type esters and alkyds. Tall oil abietic acid distillate was used as a rosin substitute in making ester gum and modified phenolic resins. A vinyl ester was produced by reaction of tall oil acids with acetylene at the Ludwigshafen plant of I. G. Farben. It was used as a coating vehicle.

Crude tall oil, despite its color and odor, has many uses. It has been used as a flotation reagent in ore concentration, as an emulsifier or additive in asphalt road construction, in the manufacture of low-priced soaps for industrial cleaning, in making linoleum and in other uses. Refined tall oil, combined with reagents, does the job of other oils at about half the cost. Thus it has been used instead of linseed oil in paints and varnishes. It is also widely used in making soaps, emulsifiers, insecticides and disinfectants. It is used in metal processing, cutting and lubricating oils, core oils, textile processing oils and other industrial products.

Sterols, higher alcohols and other unsaponifiable matter are also contained in tall oil. Solvent extraction of the sterols, although difficult, is possible. Phytosterol, derived from tall oil, is now produced commercially by Croda, Ltd., in Great Britain. Hormones can be synthesized from these sterols.

At its low price, tall oil competes with fats, oils and fatty acids. Refined tall oil sells at about 6c. a lb. Even after addition of reagents, esterified tall oil sells for less than competitive materials.

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Wrinkle-resistant finish for cotton textiles is available to mills and finishers, American Cyanamid has announced. Superset, as it is called, is a modified melamine resin. Tests show an anti-crease rating of 3.0 to 3.6 in both warp and filling. Loss of tensile strength is held down to a maximum of 8 percent, while abrasion resistance is increased. Shrinkage is kept within 2 percent. The finish will cost from 3c. to 10c. a yd., depending on weight.

•

Basic magnesium plant at Henderson, Nev., will now be able to get abundant power from Boulder Dam. Lack of power from a guaranteed source has been a big barrier to chemical expansion there. Now that the magnesium plant has been sold to the state of Nevada, it will be possible to unleash Nevada's enormous quota of Boulder Dam electrical energy for production of chemicals at Henderson. California is now using the Boulder Dam power allotted to Nevada. Through an agreement with the California interests, however, Nevada can draw on all the power it needs on short notice. Henderson had a $24 million price tag, but Nevada paid $1 down and has 20 years to pay the balance out of revenue from leases.

CHEMICAL ENGINEERING

with CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902 MAY 1948 SIDNEY D. KIRKPATRICK, Editor

WHAT COURSE PROCESS ENGINEERING?

WHERE have we been—and where are we going? These ubiquitous questions were at least partially answered, we hope, in our annual economic review in February. This month the emphasis shifts to technology where there is even more need for sober study and stock-taking. Process engineering has come a long way since we last attempted to balance the books in a critical analysis of its technical assets and liabilities. Yet before we can push farther ahead, we must know where we stand and the direction in which we are moving. To help us all in plotting the future course of our profession, the editors of *Chemical Engineering* present in this annual technological issue an unusually comprehensive appraisal of the unit operations and related processes and techniques of application. We respectfully commend it for your study and use.

BACK TO ERSATZ?

COMMODITY markets, especially for industrial raw materials, remain confused. In a few cases foreign goods have begun to move again, such as copra to aid in supply of fats and oils. But there are vastly more cases in which inadequate supply continues to be a major problem for many process industries.

This has a dual meaning for chemical engineers: it provides a new spur for research and development of alternative raw-material sources; it imposes on management the need for careful study of inventories and stockpiles.

Some of us have been looking forward hopefully to the time when ersatz materials might be largely eliminated. That solution, were it possible, might be the easiest. Certainly it would be the simplest. But trying times, such as those we now face in the international situation, can also prove an incentive for the profitable development of competing processes and materials. We must again be thinking about replacing resources with resourcefulness.

THE PUBLIC HAS RIGHTS, TOO

THE RIGHT to strike has come to have in America a certain standing which is fully justified. Today no organized group of workers should be deprived of that right casually or by indirection. But when it is so exercised as to produce general inconvenience, actual hardship and potential danger, then it becomes evident that unrestricted right to strike at basic enterprise cannot be tolerated indefinitely.

Washington found means to prevent, for at least a while, an interruption of atomic-energy operations at Oak Ridge. It did not find means, however, even to postpone the perennial interruption of coal production with its attendant hardships to the public and to the unionized workers not only in the mines but also in coal-using industries. Thus the majority suffers because an entrenched minority wants to argue about its own welfare funds.

In such cases it is easy to say but hard to apply a principle of majority rule. We do apply it at the ballot box. We have not yet learned to apply a comparable appraisal of majority wellbeing in limiting the scope of labor disputes.

This difficult problem of serving the greater good of the greater number must have thoughtful study and ultimately some constructive action. We have no panacea to offer. We merely pose the problem as one worthy of the best minds in all divisions of society.

FOR BETTER CIVIL SERVANTS

FOR a long time the Civil Service Commission has followed an unfortunate policy in the hiring of engineers and scientists. Openings have been all too briefly and inadequately announced. Sometimes invitations, both for written examination and "non-assembled" application, have reached potential applicants long after the positions have been filled.

Recently the Commission has announced a new policy which provides an opportunity for chemists and chemical engineers to make application at any time during the balance of this calendar year. Those who apply early are most likely to obtain the positions immediately open. But in any case it is expected that later applicants will have adequate opportunity to fill other positions as they become available in the salary range of $3400 to $5900.

TECHNICAL SKILL STILL NEEDED

CONGRESS has set the pattern for synthetic rubber manufacture for two years or more to come. Two hours before the authority of Rubber Reserve expired, Congress passed and the President signed public law No. 469 which continues governmental control on a sound and businesslike basis.

Ultimately American industry is going to take over

the job of manufacturing synthetic rubber and its chemical raw materials. Meanwhile the government intends that there shall be a going enterprise and also sufficient standby capacity to protect this country against another serious rubber shortage.

The important thing, it seems to us, is that the government must continue to permit effective businesslike management, which in this case means an abundance of technical skill in both operation and administration. The law contemplates this. In fact, the law provides very satisfactorily also for both fundamental research and sound industrial development.

Fortunately, the technical skill which is needed has been available in this work to a very gratifying extent. It is hoped that none of the bitterness and debate over legitimate differences of opinion on policy will in any way deprive Rubber Reserve of such talent and leadership in the critical years ahead.

FOR FORTY YEARS, CONGRATULATIONS

Last month in Chicago our respected and slightly younger contemporary, *Industrial & Engineering Chemistry*, celebrated its fortieth birthday. Many editors and publishers, including the distinguished Dr. T. W. Jones, editor and manager of publications for Britain's Society of Chemical Industry, joined in making this a happy and memorable occasion. All paid well deserved tributes to Walter Murphy and the eminent men who had preceded him at the editorial helm of "I. & E. C." Real credit should also go to his hard working associates and to the progressive management of the Society that over the years has made it possible for this journal to record so many of the research achievements of the chemical world. To all concerned, sincere congratulations and warm regards!

REFORM OR DIE

Some of the co-op groups are worried by the threat that taxes will be applied to them just as they are applied to all other businesses. Recently one spokesman for a group of Midwest co-ops talked about "vote stacking" by their critics. They urged that co-op organizers and members start a campaign with Congressmen against those who would tax their form of business.

That would not be our solution. We feel that the co-ops in many cases render a genuine service, either to members or the public or both. We think that properly managed co-ops are not threatened. We think those who are not working in the public interest, as well as for their members, must reform or they will naturally and inevitably pass out of existence. There can be no permanent service to a limited group at the unfair expense of the general public.

A DESERVED REBUKE

Commissioner Waymack, of the Atomic Energy Commission, has taken to task some self-appointed spokesmen for science. Even though we ourselves may have been guilty occasionally, we nevertheless believe him fully justified in his remarks before the American Association for the Advancement of Science when he said "I have become rather weary hearing it said that 'the scientists think,' or 'the scientists demand,' and other variations of that. The assumption, which I consider naive, is that all scientists think alike and demand alike, and that with respect to any specific issue it is safe and correct to generalize about scientists in that careless way."

Many of those who have undertaken to speak broadly for science lack both the authority and an understanding of scientists' thinking. The saner minds will realize that scientists are not going to step in and take the place of legislators and public officials in fixing policy. We wish that they would not credit all of us with such desires. It is not becoming to the realists among scientists to be so classified.

ANOTHER AWARD FOR POSTWAR PROGRESS

Each month brings into commercial fruition an increasing number of important chemical engineering developments. The process industries seem to be approaching peak performance as construction programs are being completed for plant expansion and the production of new products and materials. So intense is the interest in this progress and so many companies are deserving of recognition that we have decided not to wait until 1949 to sponsor another Award for Chemical Engineering Achievement. Instead, as announced on pp. 134 and 135 of this issue, the ninth in this series will be presented here in New York next November at the time of the annual meeting of the American Institute of Chemical Engineers. Meanwhile the Committee of Award, under the continuing chairmanship of Professor Emeritus Alfred H. White, will be pleased to receive your nominations and suggestions.

BACK TO THE UNDERWOOD TARIFF

Tariff cuts made by trade agreements recently promulgated will return the scheduled duties on imported chemicals to the approximate levels of the Underwood tariff act of 1913. Thus the Administration assumes the responsibility for returning to a policy of "tariff for revenue only."

That free-trade philosophy may not be immediately dangerous. Too little manufactured goods are available abroad to permit any flood of imports into the United States. Hence the impact of the new tariff rates will be negligible on most classes of commodities—in fact, encourage the import of badly needed materials. The magnitude of later effects cannot be determined now, nor usefully discussed here.

Basically, the consideration which the process industries must give to this question is this? Is America ready for a virtually free-trade policy? Generalizations on that question are, of course, difficult, perhaps dangerous. But we suspect that some new enterprises requiring large investments may be made more cautious by the prospect that they will not be protected against the competition of imports from areas where labor rates are a small fraction of American wages. Sooner or later this question will have to be fought out on the floor of Congress.

PROCESS ENGINEERING

* * *Plots Its Course*

***A Chem & Met* REPORT**

What is present state of the art in process engineering? Future trends? Where are weak points? strong points? The editors of Chem & Met have sounded industry for the answers. They find some unit operations still short on fundamental data, but gaps are filling, new operations appearing.

ALTHOUGH it is a rhetorical question, chemical engineers ought to ask themselves occasionally where we are going in process engineering. That is the question that *Chem & Met* editors have pasted in their hats for 1948. Changing it only to substitute "industries" for "engineering," it is the question they attempted to answer from an economic standpoint in the 25th Annual Review that appeared in February 1948. The subject of the query could be changed endlessly this year, for it is a time of uncertainty on every front, and a year in which stock-taking and appraisal are thus more than usually welcome.

For more than 20 years *Chem & Met* has devoted one spring issue, either April or May, to attempting to answer that question for some particular part of the engineering that motivates chemical engineers. Among these have been many "firsts," including the first comprehensive treatise on process control; the first appraisal of the unit operations from an "assets" and "liabilities" standpoint; the first sizable collection of process industry flowsheets; the first history of the unit operations; the first comprehensive symposium on continuous processing; and the first extensive attempt at rationalization of estimation of process equipment costs.

Now that May 1948 is here, there is a reason why this issue in particular should have been selected for the job of surveying the present status and the trends in process industry technology. In 1934 a cycle of unit operations studies was started with what we called our Balance Sheet issue. In 1947 that cycle was completed. Now it is time to start another such cycle. To change the metaphor slightly, it is time to plot a course toward the objective of better and more efficient processes and plants. Since the objective lies over the horizon, it seems to us as editors that the logical way to start the journey is to find first where we are now, then lay off the course on the chart with due respect for the submerged rocks and shoals that lie ahead.

Finding the Course. . . . .

As a first step to help us lay out the course—and to help you to follow it—we have re-surveyed the interrelations of all the unit operations. Back in 1934 we presented a chart which gave the first inclusive classification of unit operations. We believed that the usual lists of 20 or so were inadequate and that a reasonably complete picture of the whole field was needed. This we have done again using the 1934 chart as a basis, but modifying and expanding it as experience has suggested. The overall emphasis has been altered slightly and the original chart has grown from one to five charts. Two of the five have expanded so much, in fact, that one has been broken into two charts in the following pages, and another into three.

To make the whole scheme clear, a chart on the next page presents a briefed-down version of the entire group of eight charts and emphasizes the scheme of classification we have used. Analysis shows that there are five main sorts of operations involved in any chemical engineering process, in altering raw materials or raising their form value to the level of intermediates or finished products. The names chosen for these groups of operations may not be immediately familiar as unit operation names, but a little explanation will make the logic clear.

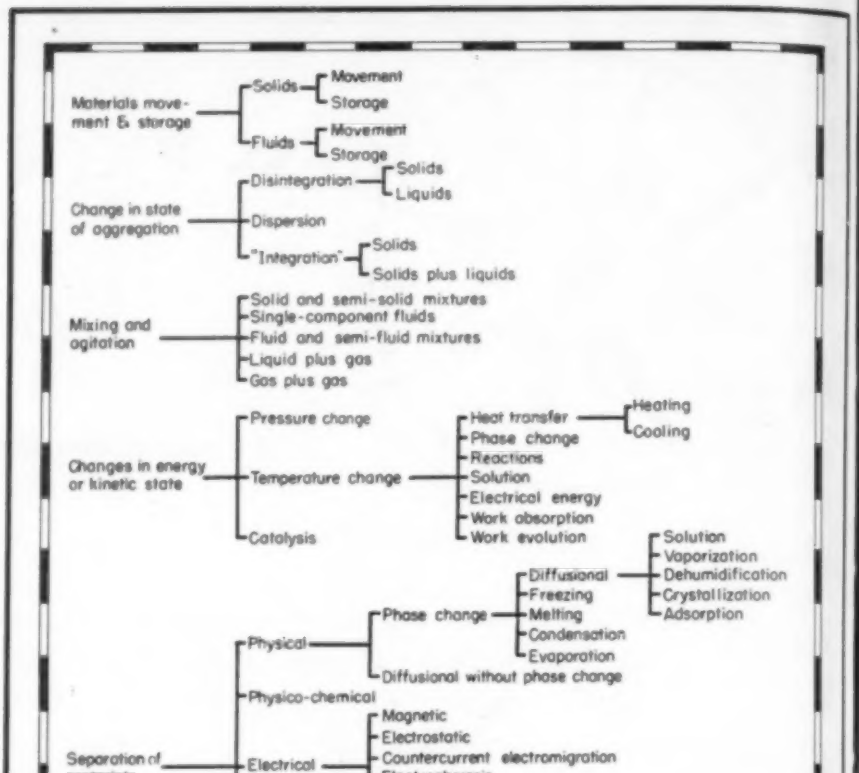
First, materials have to be brought in, stored, moved through processes and intermediate storage, and finally moved out to the market. The first two charts then cover materials movement and storage and deal with solids and with fluids.

The third chart covers those opera-

Fifty Technical High Spots in Chem & Met Since 1925

1925	(Sept.)	Unit Operations History
1927	(Sept.)	Steam for Power, Process
1929	(Apr.)	Process Control
1930	(Apr.)	Materials Handling
	(Sept.)	High Pressures, Temperatures
1931	(Apr.)	Plant Design
1932	(Apr.)	Heat Technology
1933	(May)	Unit Operations Review
1934	(May)	Unit Operations Review
	(Dec.)	Mech. Power Transmission
1935	(May)	Unit Operations History
1936	(May)	European Chemical Engineering
	(June)	Automatic Packaging (also July)
1937	(May)	Fluid Flow
1938	(May)	Mechanical Unit Operations
1939	(Feb.)	Cooling Towers (also Mar., Apr.)
	(May)	Equipment Design
1940	(May)	*Conditioning of Gases and Air
	(July)	*Mech. Power Transmission
	(Aug.)	*Measurement, Control of pH
1941	(Mar.)	*Energy Supply
	(May)	*Plant Design
	(June)	*Water Treatment
	(Aug.)	*Process Steam, Power
	(Dec.)	*Process Equipment Costs
1942	(Mar.)	*Electronic Devices (also Apr.)
	(May)	*Diffusional Operations
	(Oct.)	*Recent Advances in Catalysis
1943	(May)	*Process Control
	(July)	*Centrifugal Separation
	(Oct.)	*Bulk Packaging
	(Oct.)	High Vacuum (also Nov.)
1944	(Jan.)	*Filtration
	(May)	*Heat Transfer
1945	(May)	*Continuous Processing
	(July)	*Process Control Methods
	(Aug.)	*Waste Disposal
	(Nov.)	*Materials Handling
1946	(Apr.)	*Weight Control
	(Oct.)	*Atomic Energy for Power
	(Dec.)	*Gas Turbines
1947	(Jan.)	*Oxygen Manufacture & Use (also Mar.)
	(Apr.)	*Fuel Technology
	(May)	*Equipment Cost Estimation
	(June)	Equipment Cost Articles (also July to Jan.)
	(July)	*Ion Exchange
	(Sept.)	Centrifugal Compressors (also Oct. to Jan.)
1948	(Jan.)	*Water Treatment
	(Apr.)	*Packaging
	(May)	*Unit Operations Review

* *Chem & Met* Report.



tions where materials must be broken down into a finer state of subdivision; or conversely, where they must be "put back together" again. This means that powders may have to be compressed into tablets, ores consolidated by briquetting, or solids impregnated with liquids. Such operations here have been considered as changes in state of aggregation.

Just as commonly as materials have to be broken down into smaller aggregates, they have to brought into intimate contact, with a thorough "shuffling" of the same or different phases. The fourth chart brings together the operations comprising one form or another of mixing and agitation. It points up the fact that mixing and agitation are generic terms rather than unit operations.

The fourth class of operations, brought together in the fifth chart, are thought of primarily as being auxiliaries to the unit *processes* (reactions), and to other unit operations. These are the operations involving changes in energy level or in kinetic state of materials. The optimum conduct of reactions calls for control of energy level—that is, temperature or pressure—of the reactants. Some reactions demand catalysis to reach an optimum reaction speed or degree of selectivity, and catalysis has an effect comparable to energy level control. In many unit operations of the other groups, control of energy level also is required, for example, to bring about a flow of heat in phase change separations, or a suitably low pressure in high vacuum distillation.

The fifth class of operations, dealt with in the last three charts, includes those in which materials in a state of mixture have to be separated. Unit operations of this class are the most numerous of all. The first chart on separations is concerned with the physical methods where separation takes place at a molecular level and usually requires phase change. It includes also the physico-chemical separations in which the action may in part be of reaction nature, although the general mode of separation tends to follow unit operations character.

Electrical methods of separation occupy the second chart of the fifth group and include those in which magnetism, electrostatic charge or ionic movement due to electrical manifestations are the basis of separation. In the last of the charts the mechanical separations are encountered and here the resistance of some mechanical element or of a fluid, or a difference in density, are used to effect separations at a macroscopic level, either of size from size, of phase from phase, or of species from species.

Our Navigation Aids. . . .

No such classification as we have attempted here can be completely logical and it is not difficult to find severe fault with some of the ways in which these charts have been set up. They are not offered as a hard and fast arrangement that cannot be improved. Simply, they are "aids to navigation"—buoys and lighthouses, if you will—on the course toward better and more efficient processes. Their purpose is to help insure that no useful method will be overlooked in

attempting to reach a given objective.

Even more important as navigation aids is the advice that has been given freely to your editors by a great many engineers. To us as editors it seemed that the most logical way of finding our present position, and discovering what lay ahead on our course, would be to consult the people most likely to know. Well over 100 engineers, each a specialist in some phase of the problem, was consulted in detail. What these men told us has been analyzed, boiled down, and then condensed again. It has been set down here—present position, newest aspects, trends, prospects—hitting only the high spots. It has been recorded in digest style to save our readers many thousands of man hours in total, and yet to give a quick and accurate look at hundreds of sides of the general problem.

All this, obviously, is only the plotting of the course. The actual ports of call to which we shall take you, the readers, in subsequent May issue studies of the unit operations and other phases of process engineering, will show how accurately our course plotting was, and how expert our compensation for disturbances along the way.

Weather Signs. . . . . .

Even before we start our journey of the next decade, there are many signs in the following pages of which all of us, as "old sailors," should take note. These are the highlights and the trends. In materials movement, for example, we find a general trend toward automatic operation, and as a highlight, the remarkable development of industrial trucks and their accessories. In "state of aggregation" the most notable point is the move toward finer particle sizes, bringing with it the jet powered mills. In mixing the biggest fact ahead is the trend toward more science, less art, while in operations affecting energy level, the extremes of high pressure, high temperature and high heat flow rates are the things to watch. Separations too have their spots, the new separations of "hypersorption," chromatography and ion exchange being perhaps the most valuable tools of process engineering that have appeared in many a year.

Process engineering encompasses many things that are not unit operations. A few of these, some of which are very big news indeed, are treated briefly in a short final section, including fluidization, ultrasonics, process and quality control, and power production and use. Many non-unit-operation phases of process engineering have been omitted entirely. For the moment, a quick survey of the course ahead—for the details, the issues of May 1949 to 1958!

Acknowledgements. . . . . .

To the large number of men who gave advice and assistance in the preparation of this appraisal, *Chem & Met* makes grateful acknowledgement. Most of them are listed below, the numbers identifying the subjects on which they were consulted. Following is the key to these subjects:

(1) Absorption; (2) Adsorption; (3) Air Conditioning; (4) Boilers; (5) Catalysis; (6) Centrifugals; (7) Chromatography; (8) Compressors; (9) Concentration Methods; (10) Cooling Towers; (11) Crystallization; (12) Diffusional Operations; (13) Distillation; (14) Drying; (15) Dust Collectors; (16) Evaporation; (17) Filtration; (18) Fluid Dynamics; (19) Fluidization; (20) Gas Turbines; (21) Grinding; (22) Heat Exchange; (23) Heat Transfer Media; (24) High Pressure; (25) High Vacuum; (26) Ion Exchange; (27) Liquid-Liquid Extraction; (28) Magnetic Separation; (29) Materials Handling; (30) Mixing; (31) Molecular Distillation; (32) Motors; (33) Pebble Heaters; (34) Piping; (35) Process Control; (36) Pulverizing; (37) Pumps; (38) Refrigeration; (39) Screening; (40) Spraying; (41) Subliming; (42) Ultrasonics; (43) Unit Operations.

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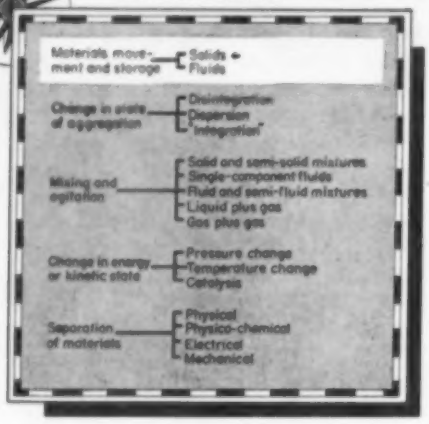
PROCESS ENGINEERING PLOTS ITS COURSE



Movement of Materials

MOST UBIQUITOUS of all unit operations are those concerned with the movement of materials—into the plant, into and out of storage and processing steps, through various processes, and, finally, out to market or to the ultimate consumer. Since materials characteristics vary widely, while mode of movement itself must be in tune with plant pecularities and process needs, equipment for materials movement has become extremely diversified. Roughly classified, materials are moved and stored as solids—which includes handling and storage of fluids in movable containers—or they are moved as fluids, giving rise to two main sections in this report. Fundamental differences between these two classifications may be distinguished by whether the principle is primarily mechanical (as in most solids handling), or primarily dependent on fluid dynamics (as in most fluids handling). The first case results in little theory except in so far as the designer is concerned, whereas in the second case, one of the chemical engineer's most important concerns lies in dynamics of fluid flow.

Solids Movement . . . . . .

Many solids-moving methods are available. Although some classifications are based on direction, such as horizontal movement, vertical or inclined movement, or combinations of these, there is much overlap and a better breakdown is by (*a*) continuous flow, (*b*) intermittent flow, as in the unit operations chart given here.

Solids-moving equipment has tended to become minutely specialized. Some is distinctly special-purpose while more general equipment also shows this trend through often unnecessary variations among manufacturers. A favorable side is that handling equipment can generally be found that fits flowsheet needs exactly. Against this is undue complication in maintenance, longer deliveries on new equipment and repair parts, and probably higher-than-needed cost. Considerable improvement, it is felt, could come from well-considered efforts toward standardization, whether on an industry basis or among lines of individual manufacturers. It augurs well for the future that standardization needs are already being discussed in some quarters.

Roots of almost all present solids-handling means were well developed years ago and really new types are seldom introduced, although new and usually specialized variations of older ideas are not uncommon. Considerable improvement has been noted in construction materials in recent years, as well as in design modifications that make for lower maintenance. Means for reducing or virtually eliminating frictional effects have been common, as well as improvements in bearings and in bearing seals to exclude dust and lessen lubrication frequency. Newest ideas have been in applications and variations of industrial trucks, particularly fork trucks and pallets; in portable equipment to permit ready rearrangements of flowsheets; and in equipment specifically adapted to process industries needs, rather than adapted from other industries. War-developed equipment for earth moving has been adapted to outdoor storage and reclaiming needs, with important advantages for large-scale operations. Fluidizing, where employed for solids movement, is certainly outstanding as a recent development in spite of its use for many years as a basic principle of the Fuller-Kinyon solids pump.

Materials movement by machinery has already eliminated much manual drudgery from plants handling solid materials. Claims made that industry in general can reduce over-all production costs by 15 percent or more through further utilization of handling equipment may not be justified in most process plants, but improvement can still be made nevertheless. For many types of operation no deterrents other than labor attitude and sheer economics need stand today between present methods and fully automatic plants. Trends toward complete automatization of solids handling, however, in most cases will follow other developments in plant operations, such as adoption of continuous rather than batch processes.

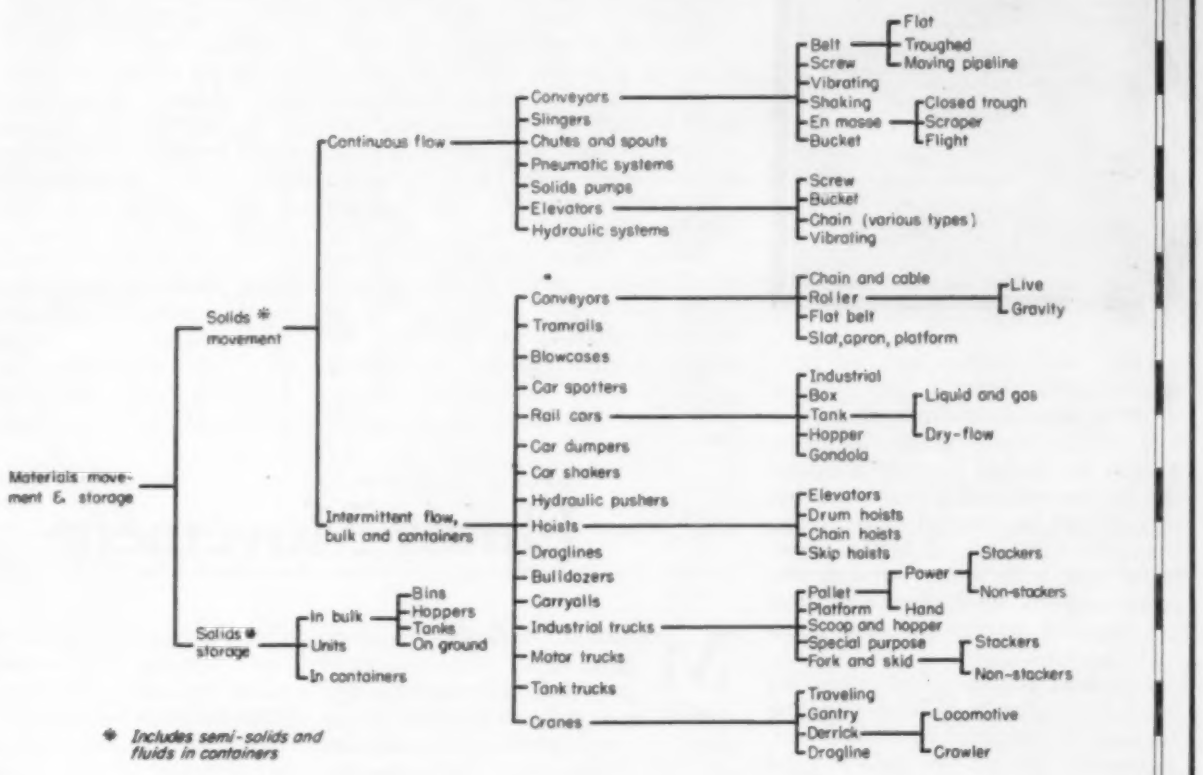
Continuous Flow—Bulk solids may be handled continuously by conveyors of numerous types, by slingers, by chutes and spouts, by pneumatic and hydraulic systems, aerated-solids pumps and by elevators of several sorts. Material character often determines choice. For example, materials in packages and containers inherently involve discontinuity in flow although the equipment itself may move continuously. Materials in bulk, however, tend to favor continuous flow on continuously moving equipment, except where distances involved are excessive, or quantities insufficient.

Conveyors—Belts themselves have been greatly improved, both in structure and in construction materials. Longitudinal cord construction is now available which permits more than doubling working load per ply per inch width, compared with the best earlier cotton duck carcasses. Rayon, nylon and glass fiber carcass constructions are now produced for special purposes, with improved cover formulations involving both natural and various specially suited synthetic rubbers. A carcass of nylon combined with treated duck has been developed with a load rating three times that of earlier comparable designs, while steel wire-reinforced carcasses have been put on the market for loads of 1,000, 2,000 and 3,000 lb. per inch of belt width. In addition to ability to produce longer-lived belts for more severe service, these factors mean availability of much greater lengths than a few years ago.

Some improvement too has occurred in belt idlers and accessories. Better bearings, means for ready troughing adjustability, flexible idlers to save belts at loading points, improved unloaders, surer belt cleaning and tracking devices, are most notable.

Among other conveyor types, fundamental improvements have not been numerous although a few have been recent. Most novel is Stephens-Adamson's "zipper" conveyor, a belt type conveyor with folding edges carrying molded teeth which can be "zipped" together by roll pressure for tight inclosure of material carried, or opened for discharge and reloading at any point in a path that may be horizontal, vertical, inclined, or any combination of these. This latest variation of the moving pipeline idea is handling materials ranging from coarse abrasives to corrosive chemicals.

Numerous modifications have occurred in vibrating conveyors which



now are applied to drying, cooling, mixing and elevating (by means of a spiral) as well as to straight conveying and feeding. Improvements now permit handling hot, dusty, magnetic materials without trouble. Similar diversification is evident in en masse conveyors which spread to several manufacturers shortly after their original introduction. Modification occurred in layout, method of connecting conveying elements, in drive and in protection of products handled from possible lubricant contamination.

Other Continuous Machines—Pneumatic and hydraulic systems remain much as they were, with one striking new idea—incorporation of the fan into the outlet side of the collector so as to use the fan both for movement and for secondary fine dust separation after the primary cyclone separator. Another class—slingers or centrifugal belt loaders—now has several specialized modifications, for example, a ship loader and trimmer, and a box car loader so hung from a spout that it discharges in any direction through swivel action.

Intermittent Flow—Such methods are even more numerous than those imparting continuous flow, including all long-distance methods (except long belt and cable conveyors, and flumes), as well as intra-plant movements of packages, containers and products of unit character. Conveyors for unit loads, rail cars, road and industrial trucks, many elevating devices, many means for bulk storage and reclaiming, are of intermittent character. Striking improvements appear mainly among industrial trucks, bulk handling means and small portable conveyors.

Conveyors—Except for advent of light-duty "skate-wheel" roller conveyors, and adjustable-angle belt elevators for both packaged and bulk materials, intermittent conveyors have seen little recent change. Skate-wheel conveyors are built in numerous standard units, including curves and switches, for assembling into any desired gravity conveying layout, with or without belt elevators for providing needed height at intervals. Like the latter, they are readily portable, and permit rearrangement if desired.

Bulk Handling—Means for rapid car unloading, and storing and reclaiming tremendous tonnages, were important wartime improvements with implications for future expansion. Bulldozers, for example, are being used in distributing bulk materials in outdoor storage, especially in stockpiling coal by the layer method, where compacting is used to avoid heating in storage. For more radius of action carryalls, developed also for earth moving, are employed similarly to bulldozers. The latter device, a self-loading wheeled scraper and carrier which digs and carries, or discharges and levels, in one chemical plant requires the services of one man to move 130 tons per hour over a 250-ft. radius, at a cost under 5c. per ton including equipment charge-off. Also for outdoor storage, crawler cranes are apparently replacing more expensive crane types, both in stockpiling and in reclaiming. In car unloading, tremendous speed-up in hopper car discharging is being accomplished with negligible power consumption through electric car vibrators. A car of frozen coal is unloaded in about 10 minutes, with 2 to 5 minutes needed for unfrozen material.

Intermittent operation is also used in pneumatic handling of a type fusing characteristics of both the liquid blow-case and the solids pump. A recent development on these lines, the Convair system, aerates material in a closed conical hopper under pressure from a

positive blower, then uses air pressure from this blower to force material in dense aerated condition through a line of relatively small diameter. Lumps up to half the line diameter can be conveyed and it is claimed that material can be handled in any direction, through long distances, dustlessly, and with about one-fifth the power and one-third the air or inert gas required by conventional pneumatic systems.

Industrial Trucks—Most interesting of all developments in solids handling are those in industrial trucks and their accessories. Except for loads of great weight, or where high floor loading is not permissible, the trend has been away from fixed and elevating platform types, and toward fork and specialized types adapted for particular types of loads. Standard fork trucks may now be equipped with many special attachments (some readily interchangeable) for handling drums, rolls, containers that must be dumped, scoops, stacks of brick without pallets, piles of cartons stacked only on a sheet of corrugated board. Some trucks now pick up cartons by side clamps, without forks, push and pull them on to or off of pallets. Practically any specialized need can be met by attachments already available, with others only waiting development of a demand.

Pallets themselves have undergone few fundamental changes. Plywood is tending to replace hardwood for weight saving, with wire, sheet aluminum and sheet iron designs available. Expendable pallets, confidently predicted two years ago, are still under development, largely because of difficulties in securing adequate strength at low enough cost. More important than the prospect of disposable pallets, perhaps, are prospects for more favorable freight rates on pallets than at present apply. Equally as striking as equipment advances, and probably even more fundamental, is the tremendous study that wartime needs and later industrial requirements have caused to be applied to the concept of "unit loads." Applied first to "materiel" and now to materials, such study has probably had more influence on shipping and handling methods than any other development of recent times. Handling is almost completely mechanized, re-handling largely eliminated, space utilized to greatest possible advantage, movements greatly expedited in comparison with earlier methods.

Associated also with unit loads are certain other developments of comparatively recent vintage, including glued loads in which all cartons on a single pallet are glued together to eliminate shifting without need for strapping. In furtherance of mechanization of pallet handling was the recent development of an automatic pallet loader into which pallets and cartons are fed, the latter emerging stacked automatically according to whatever pattern best fits requirements of the type of load. Hand pallet trucks also have evolved, first to substitute power for all human effort except for guiding the truck, and recently to add a stacking feature. Also recent is the trend toward use of power "wheelbarrows" and scoop trucks which multiply a man's ability many times as compared with their manual equivalents.

It is clear that in most solids-handling methods mechanical improvements are being made from time to time, and with few exceptions nearly all classes are increasing in use as the inevitable trend toward more horsepower per worker continues on its way.

Fluids Movement

MOVEMENT of fluids—liquids or gases—is an essential part of practically all chemical and related processes. And since many processes are headed toward extremes of both higher and lower pressures, fluid flow and the means for bringing it about are of increasing interest. At the same time, quantities of fluids to be moved are increasing in many industries and higher efficiencies are becoming more essential even under more moderate conditions of operation.

Fluid Dynamics . . . . . .

Long considered as a unit operation, fluid flow has been little studied in the United States, so that English and German correlations still form the basis for most United States design. For flow of gases and solids through pipes these correlations are adequate. Only problem—the basic work was done on fairly corrosive materials, water and moist gases in steel pipes. Hence for non-corrosive materials, too high safety factors result. For more corrosive materials than water or steam, the safety factors in the formulas may be too low.

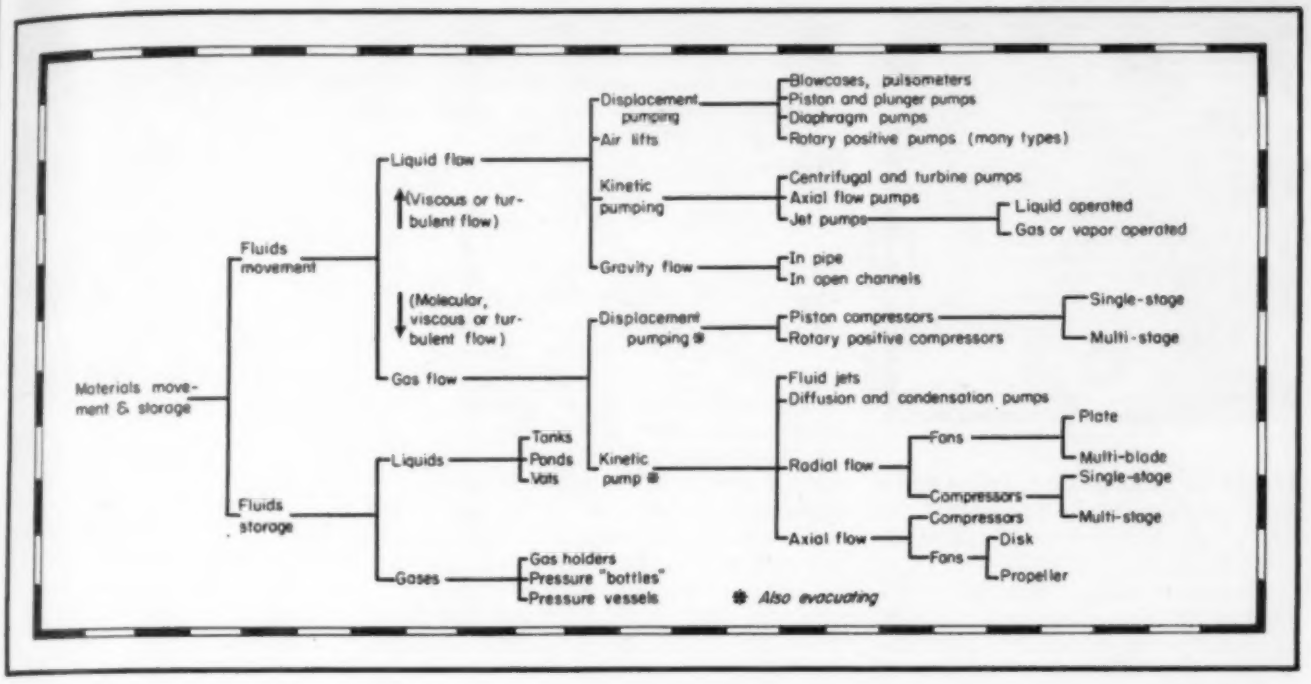
For other flow problems the situation is not as good. Much work has been, and is, going on to determine pressure drop through beds of solids and through heat exchangers. Even so, methods are largely empirical today. On heat exchangers the situation may be altered by work now going on for standard types of equipment, tube sizes, baffles, etc.

A new problem in fluid flow is use of fluidized solids. Although organizations working directly with fluidized solids have data on such fluid flow, little has been made public. Some university and institute work is now coming out. But so far, pressure drop in fluidized reactors has not been too important. Carry-over has limited gas flows, not pressure drop. With tendencies toward operation of fluidized reactors at higher pressures, the economics of compression may make pressure drop important.

One major problem which developed during the war was calculation of flow problems for very low pressures. High-vacuum processing expanded tremendously for such operations as the K-25 gaseous diffusion plant at Oak Ridge, and production of magnesium by sublimation from ferro-silicon-dolomite. More recently growth of high-vacuum distillation and drying has introduced fluid dynamics problems at low pressures.

Low-pressure fluid flow differs from conventional turbulent and viscous flow in that collisions between individual molecules are essentially lacking. This type of flow is called free molecular. It becomes important when pressures get down to about 100 microns Hg. At the pressures often found in high-vacuum work, roughly 10 microns and below, almost all flow is molecular.

Development of satisfactory design formulas for use in designing high-vacuum equipment was accomplished for the Manhattan District and these have become available for general use. (See Dryer, *Chem. Eng.*, Nov. 1947, pp. 127-131, and Dec. 1947, pp. 122-



124.) Published equations and design data not only cover the free molecular flow range, but also permit calculations in the intermediate range where free molecular flow and viscous flow co-exist.

Equipment for Fluid Flow . .

Liquid Pumping—Liquid pumping has always been a fertile field for inventors, with the result that types of pumps are legion. For smaller capacities types are by no means standardized, and many different varieties are used. In larger pumps and those for higher pressures, effort has been concentrated on a smaller number of general designs. A trend is evident away from reciprocating pumps, toward centrifugal and rotary types, except for highest pressures and viscosities. In pipeline work, the largest field for large reciprocating pumps, a notable tendency is to go to five, seven or nine cylinders, compared with older duplex and triplex designs, and to operate at considerably higher speeds and power inputs, approaching flow characteristics produced by centrifugal pumps. In rotary positive pumps no very notable trends are evident, most of the presently used types having been well established in certain fairly limited spheres for a considerable time. More development seems to be taking place in variable-delivery pumps for hydraulic power applications than elsewhere in this field.

It is in the territory of centrifugal pumps that most of the news is being made. Among them, outstanding trends point to higher pressures, higher rotative speeds, better suction design, and elimination or improvement of shaft packing.

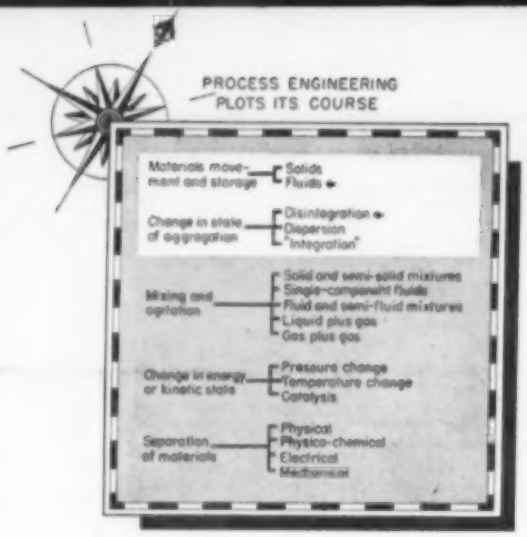
Centrifugal pumps can achieve higher pressures only by two means: higher speed, and more stages. Since 3,600 rpm. at present is the practical limit for standard a.c. motors, and since speed increasers add cost, size and weight, most high-pressure centrifugals today employ multi-staging. Although they will not come immediately, advantage exists for smaller-diameter pumps with fewer stages, operating at higher speeds, with direct-connected high-frequency motors. This possibility is suggested by present availability of electronic frequency changers.

For a number of years now it has been possible to secure multi-stage centrifugal pumps both for large-capacity deep-well service, and for smaller-capacity high-pressure service at pressures well over 1,000 psi. It has been necessary to solve many special problems, particularly where high-temperature materials are handled. Design in high-pressure pumps has tended toward the vertical. In some a double casing takes care of bolting problems. Stage layout is such that the shaft must be packed only against lower pressures.

It is in lower pressures that most interest is being shown in either improving on conventional stuffing boxes, or eliminating them entirely. Many pumps are now being turned out with mechanical seals and this is a definite indication of future tendencies. The materials problem appears to be well in hand for most non-corrosive applications. Suitable designs are now appearing for corrosive applications, as well, and eventually the conventional stuffing box may be an anachronism. However, so much success has been reported for Teflon packing in recent months, for severe corrosion problems at high temperatures, that the stuffing box may take a new lease on life.

Efforts to eliminate packing problems entirely have shown encouraging results in recent years. One approach has been to use submersible motors, as developed originally for deep-well centrifugals. Pumps of this type, similar in design to deep-well pumps, have been applied extensively in handling hot volatile liquids near their boiling points. A much older arrangement, of course, is to submerge the pump itself. One recent pump gets rid of both packing and mechanical seal by use of an ingenious centrifugal hydraulic seal in which liquid being pumped seals the suction side through what is, in effect, a rotating U-tube. Here centrifugal force "packs" the sealing liquid into the bottom of the U.

Chemical Pumps—Many satisfactory special materials, both metallic and non-metallic, are now available in standard chemical pumps for off-the-shelf shipment. Tendency seems to be away from unusual designs, back to types best understood by maintenance mechanics. It is also apparent that manufacturers now realize that a single design is not necessarily adaptable to a wide variety of construction materials, and that it may be necessary to use special designs for "standard" pumps. Chemical pumps, too, are tending strongly toward mechanical seals, al-



though in stuffing boxes Teflon packing is now showing 10 to 15 times the life of the best previous packing in some types of service.

Chemical pumps have been improving in design, in materials, in application and installation. More intensive study now being given to such pumps should go far toward eliminating present weaknesses which seem to group themselves under problems of construction material, stuffing box, "water-pump" design, and improper application. The future will see a still greater variety of construction materials, more standardization, a tendency to demand and secure greater reliability.

Pipe and Valves—Welded pipe has of course been largely standard in process plants for a number of years. Welding techniques, however, continue to improve while welding fittings are becoming available in more special construction materials including stabilized stainless alloys. A tendency is apparent to use lighter walled tubing in higher priced alloys and special fittings have recently been brought out for this purpose. A number of manufacturers are also offering lighter gage fabricated flanged fittings in such alloys. Recent development for smaller sizes of steel pipe is a line of brazing fittings which permits steel pipe to be assembled by brazing like so much brass pipe, without need for threading.

A number of special valves have appeared recently. Quite a few of these have made use of characteristics of rubber and like materials to achieve some special result, for example, the rubber sleeve valve. High-vacuum industries have required packless valves, a result that has been achieved in both shut-off and control valves through substitution of metal bellows for usual packing. In large valves attention has been given to weight reduction, for example, by eliminating conventional bonnets as in the war-developed Hobbs valve construction, which has now been adopted by several valve makers. In control valves principal efforts have been directed toward securing more accurate response, with over-all simplification and weight reduction.

Gas Pumping . . . . . .

Movement of gases and vapors seems to fall naturally into a broad band of applications over the moderate-high, to moderate-low pressure range, with specialized applications in extreme-high, extreme-low pressures. At the low-pressure end of the pressure spectrum, the diffusion pump stands alone for all but very low-capacity applications where mechanical pumps can also be used. Following extensive wartime development of the diffusion pump, improvements in intervening years have been real but much less spectacular. Likewise, mechanical pumps for high vacuum are evolving slowly, but have already reached a high level of perfection.

Ejectors—At pressures just above the extreme high-vacuum range, and particularly where capacity must be great as in many processes today, the steam jet ejector is now very nearly supreme despite its relative inflexibility and its tendency to drop its load when steam pressure falls or water temperature rises. Against it also have been failures due to misapplication where users either did not know limitations, or the manufacturer was uninformed on process needs. In its favor is the fact that it has relatively high cycle efficiency. More than this, it is often the only device with sufficient capacity. Finally, current interest in supersonic velocities has focussed a lot of attention on ejectors and improved designs are certainly in the offing. In addition, basic research now being sponsored by the industry at Battelle, primarily to determine effects of temperature and molecular weight on ejector performance, should have beneficial results.

Improved means are coming into use for ejector testing and an ASME committee is now developing a test code, initially for power plant ejectors, probably later for industrial types. Better understanding, better testing, better construction methods and materials that are already being used will aid materially. Possibly, binary fluid jets may not be distant which will be able to handle pounds of vapor at micron pressures, where present devices handle ounces.

Before passing from vacuum to the plus-pressure range, it is worth commenting that, as Freneau pointed out (*Chem. & Met. Eng.*, p. 107, June 1946), a condenser is the least expensive kind of vacuum pump to operate. Although not usually regarded as a pump, that is exactly what it is, so long as it must deal only with condensible vapors. Condensers, particularly those used with ejectors, are receiving much more attention today than in the past. Here again improvements are on the way which will improve both performance and stability of ejectors used with them.

Fans and Blowers—Where a few years ago most development in the fan-blower pressure range lay in propeller fans and lower pressure centrifugal blowers, most evident improvement now is in axial fans, and in centrifugal and axial compressors for higher pressures. Just before the war today's axial fan began to take shape. A straight-through device incorporating important features of aerodynamic theory, a fan of this type is more efficient at higher pressure than the propeller from which it developed. These characteristics come from proper fairing, new blade designs and use of vanes to prevent swirl. Many fans of this type have been introduced recently, some with motors faired within the duct, some driving from an external motor by a belt in a faired housing, others installed in an elbow so that a direct-connected motor can be outside the duct.

Compressors—In gas compression, although the reciprocating compressor retains its hold on ultra-high pressures, most interest is in rotating types. These include particularly both axial flow and regular centrifugal machines. A second tendency is to increase size of individual machines.

Centrifugal compressors have made great strides in recent years. Admittedly they suffer limitations, but there are specific applications where those limitations are not serious and where other advantages outweigh them. For instance, centrifugals are now being used on gas pipelines. Some of the biggest—for high static pressure—are the ones Tennessee Eastern Transmission Corp. is installing on the Big and Little Big Inch pipelines. Each machine puts out 156,000 cfm., referred to standard conditions at 60 deg. F. and 1.3 psig. Discharge pressure is 750 psig. They are driven by 3,600-rpm., 1,250-hp., 2,300-v. squirrel cage motors. Being boosters, actual compression ratio of 1.3 is comparatively low. One limitation of centrifugal compressors is their lack of capacity flexibility. This limitation was sidestepped neatly by Tennessee Eastern by installation of a few reciprocating compressor stations along the line to take fluctuations in throughput.

Centrifugals are going in in other places where very large volumes of gas are to be handled, fluctuations in output are slight, and compression ratio is low. For instance, the two synthetic fuel plants now under contract for Texas and Kansas will use large centrifugal compressors. Air compressors are being built to handle as much as 130,000 cfm. with an outlet pressure of 100 psig., and oxygen compressors for 20,000 cfm. and 300 psig. In these units, intercooling will be provided between various stages.

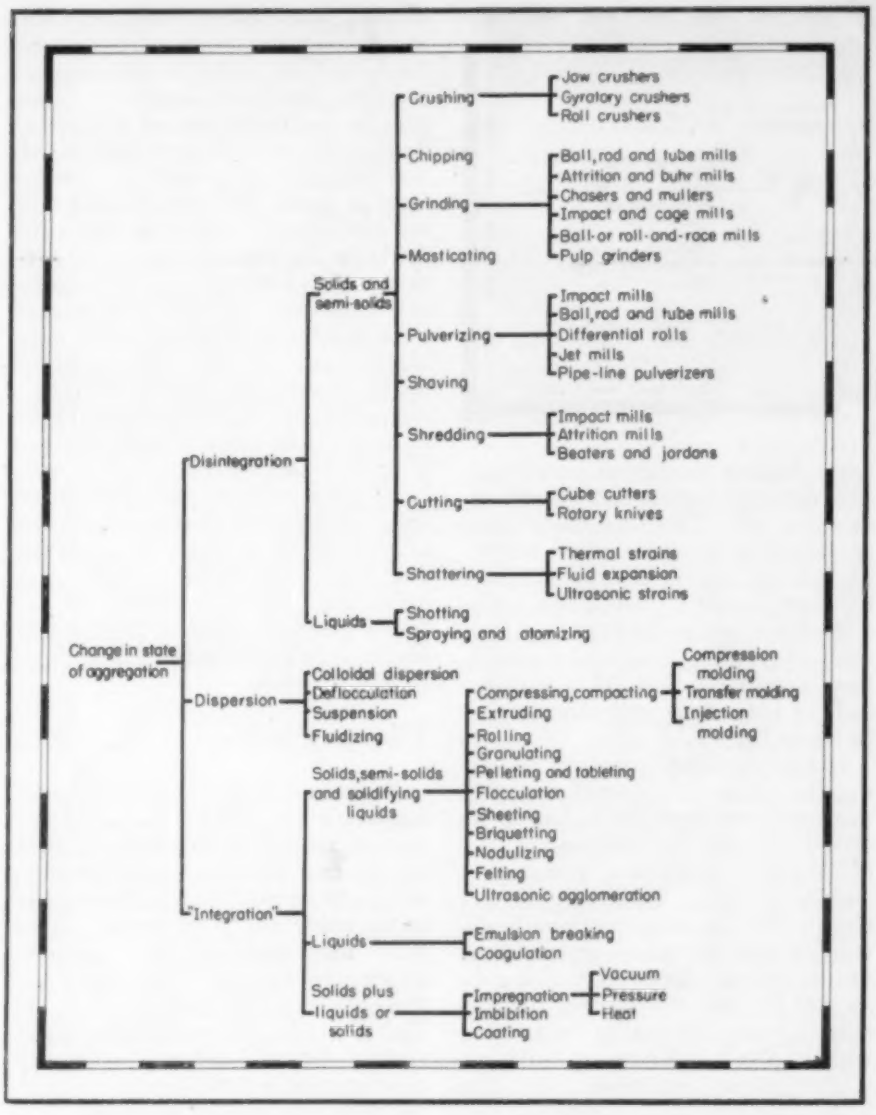
Axial flow compressors are being talked about a lot, but there are few actual installations. One of the first applications, in conjunction with gas turbines, was on air compression for Houdry catalytic cracking units. Here the axial is a natural because gas flows are large, fairly constant in rate, and fairly low output pressures are required. Also specific gravity of the gas is fairly high, an often limiting factor.

Although the reciprocating compressor seems to be losing its grip at low pressures, it is holding its own at the high pressure end. Biggest advances have been in size. 1,600 hp. with gas engine drives, 3,000 hp. with steam drives, and 2,500 hp. with motor drives. Increased reliability of operation has decreased the requirement for spares, with consequent increase in allowable size of individual machines. Among biggest recent uses are ammonia and methanol plants, where output pressure approximates 5,000 psig. With the drift of this industry southwest, toward natural gas as a raw material, has come a consequent shift to gas engine drives.

Although reciprocating compressors are working as high as 15,000 psig., it is interesting to note that intensifiers are on the increase for higher pressures. For operations involving 30,-40,000 psig., the intensifier seems to have taken over.

From a packing standpoint, there is one interesting trend in the centrifugal compressors, a trend away from packing and toward mechanical seals. The Tennessee Eastern compressors discussed above use mechanical seals of the hydraulic type, with oil as the hydraulic fluid.

For reciprocating machines, there is a lot of packing research going on, particularly for extremely high pressures. German developments in the 4,000-atm. pressure range are being investigated, together with wartime United States designs. Development of satisfactory packing is a principal problem at pressures above 2,000 atm. When this problem is licked, applications for pressures in the 4,000 atm. range will be at hand.

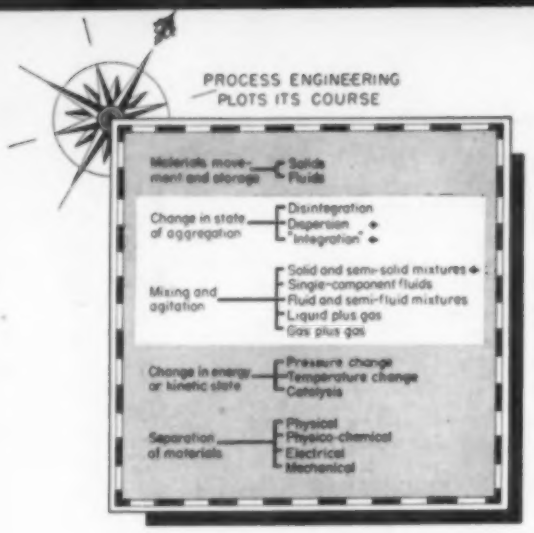


Change in State of Aggregation

A RELATED GROUP of unit operations which may be drawn together under a general heading of changes in state of aggregation includes all those operations in which material is broken down into finer state of physical subdivision or, conversely, in which subdivided material is "put back together." One may question the strict logic of some operations included here, particularly borderline operations where relatively loose agglomerations are either broken down or formed. In any event, they have been included for want of a better classification. Simultaneously, it should be pointed out that terms are very loosely used in this field, and meanings are usually not definite. Finally, perhaps even main headings of disintegration and dispersion for "breaking down" operations may be questioned, while perhaps an apology is needed for our unusual use of "integration" as a heading for "putting back together." Only lack of a better term dictated its use in this classification.

Disintegration . . . . . .

Progress through the entire field of disintegration tends to be slow and largely limited to mechanical improvements—in fact, only a few really new ideas have appeared in 25 years. For one thing, there has been little ad-



vance from a theoretical standpoint, and disintegration is still largely an empirical art. There has been some advance in recent years in grindability studies, but a good deal of this work has been limited to coal. There is also a tendency at present to approach study of grinding theory from a statistical standpoint, but it is still too early to judge how productive this attack may be.

If the preceding paragraph appears negative, it is true nevertheless that there are many favorable factors in the over-all picture. To overcome a lack of "science" there is a tremendous backlog of "art." Disintegration machinery has become enormously diversified and limitations and fields of various general classes are well known so that the best machine for any specific purpose can usually be selected with relatively little experimentation. Certain general principles have also been recognized in recent years. Perhaps the most general is that, since over-grinding absorbs power needlessly, most types of grinding equipment (except the coarsest) should be once-through machines with provisions for classification of product and return of oversize. Batch grinding has therefore been largely superseded by continuous, and most types attempt to withdraw either total product, or at least all that has reached a given size, as rapidly as possible.

Crushing—There has been little activity in coarse crushers aside from three old stand-bys, jaws, gyratories, and rolls. In the first two there has been a recent trend to alter method of applying crushing pressure, so as to eliminate simultaneous rubbing action. The claimed result is longer life and substantially lower power consumption for equipment. There appears to be no immediate likelihood of advent of new methods of coarse crushing, unless the sometimes discussed possibilities for ultrasonic shattering should materialize.

Grinding—Grinding equipment of all kinds has received much attention in recent years from a mechanical standpoint but there are few suggestions of important departures. One trend is increasing use of automatic feed control to avoid both under- and over-loading. At present a controversy is going on between ball mill and rod mill advocates which may help to clarify the fields for these two machines. The ball mill, a more important tool than rod mills in process work, is certainly going into many new applications. It has, for example, largely pre-empted business of grinding paints and it is now estimated that as much as 80 percent of all paint is so ground. Active comparison is now being made between relative merits of different kinds of grinding balls. In heavy grinding, comparison is between cast alloy iron, metal carbides and forged steel, and in the finer field, between pebbles, porcelain and certain higher density ceramics such as those based on zircon.

Vibrating Mill . . . . . .

An unusual type of German ball mill uncovered by OTS has the novel feature of mounting the shell on steel springs and adding a rapid vibratory motion to normal rotation by means of an eccentric shaft. It is claimed to grind most materials to 1 micron, either wet or dry. Laboratory machines have already been tested in the United States, but possibilities for industrial sizes will not be known until they have been tried here in comparison with best available methods.

Among other types of grinding mills, the situation is similar in that, again, mechanical improvements are being made constantly, without much change of fundamental nature. Impact mills, for example, have tended to become highly specialized, with many sorts of impact elements for specific purposes. One of the novelest recent developments is a reversible swing hammer mill for sticky materials that would tend to build up on the back breaker plate. One version of this mill employs traveling breaker plates on both sides of the rotor, which can be reversed if there is any tendency to plug. The rotor also can be reversed to enable two sizes of product to be ground alternately by adjusting clearances between the two breaker plates and the rotor. Attrition type mills have also diversified widely and are now going into a great variety of applications where a tearing action is desired.

Fine Pulverizing—There appears to have been more fundamental development in equipment for pulverizing in the micron range than in machinery for coarser work, a fact which follows from a steadily increasing interest in finer particle sizes for pigments and other purposes. This interest is evidenced both in introduction of new types of equipment, and in much active study that is being given to fine particles and methods of measuring them. Such equipment development has been moving in two directions: Toward mechanical pulverizers of high-speed impact type, equipped with improved classifying mechanisms; and toward general class of jet pulverizers. There has also been some interest in comparatively low velocity "pipeline" pulverizers in which grinding action is largely that of attrition of particle on particle.

Although as a class jet pulverizers have been regarded as expensive to operate, it now appears that they are actually more economical than mechanical machines where particle size must average 5 microns or less. Several types of jet mill have appeared in recent years. One has gone into many fine pulverizing applications, while another has been pointed specifically at coal pulverizing for boilers, but also is being tried for other purposes. Another, again for a variety of uses, is still not on the market while a fourth is under development primarily for reducing coal to a fine enough state for use directly in the combustion chamber of coal-fired gas-turbine locomotives. This last, now being perfected by Locomotive Development Committee, projects a stream of granulated coal through a nozzle by means of high-velocity air, impacting it against a target. Although the grinding action was first thought to involve explosive shattering, it is now established that action is entirely attrition and impact. This method is thought to offer advantages particularly where operation under pressure is advantageous, where simplicity and compactness are desirable, and where a high percentage of ultra-fine product is desired.

Jet action of another sort is also being applied in a number of specialized applications of which hydraulic de-barking and hydraulic de-coking are examples.

Liquid Spraying—Operations requiring atomization of liquids have been hindered to a considerable extent previously by lack of information regarding distribution of droplet sizes. As a result of certain wartime work carried on without the benefit of such data, considerable experimental work has since been done by a University of Illinois group under Johnstone and Comings. In this, experimental con-

firmation of earlier empirical equations has been obtained, pointing the way toward fuller understanding of spraying mechanisms and ability to predict spray characteristics. Another development in spraying of quite a different character that was first applied during the war years in the spray application of both finishes and porcelain enamels, is electrostatic spraying. This process is not dissimilar to action of electrostatic dust collection and achieved notable success in improving uniformity of coating, as well as in preventing loss of sprayed material.

"Integration" . . . . . .

Not many recent developments have been uncovered among types of equipment used for "putting materials back together." Perhaps the most important trend in this field is in increased use of such equipment in manufacture of catalysts and intermediate products. In molding of plastics there is some evidence of a trend away from injection, toward compression and transfer molding. Extruding and pelleting machinery is tending toward heavier duty and higher speed. Introduction of vacuum tablet presses has offered improvements such as freedom from lamination and slugging, and higher speed operation in production of larger tablets and preforms. Vacuum dearing extruders have gained extremely widespread application in ceramics and in such other manufactures as pencil leads. Coating, casting and calendering machinery also have followed the trend toward higher output.

Aggolomeration of both mists and aerosols by ultrasonic waves, which is mentioned more fully in another section, is perhaps one of the most interesting aspects of this group of operations. Impregnation operations appear to be gaining ground. Among other uses is a group of vacuum impregnations of fibrous materials, as yet unannounced, which is at present undergoing investigation by a new organization formed for that purpose. At least one of these operations is expected to put an entirely new complexion on a time-honored process in organic chemistry, speeding operations to a small fraction of the time formerly required.

Mixing and Agitation

IN RECENT YEARS feeling has grown that to put a label of unit operation on "mixing and agitation," or either of them separately, is a mistake since these words cover a class of "shuffling" operations which are markedly different in character. Any one of these is itself a unit operation. Unfortunately there is not complete agreement regarding terms that should be used for individual operations so that some words employed here had better be defined.

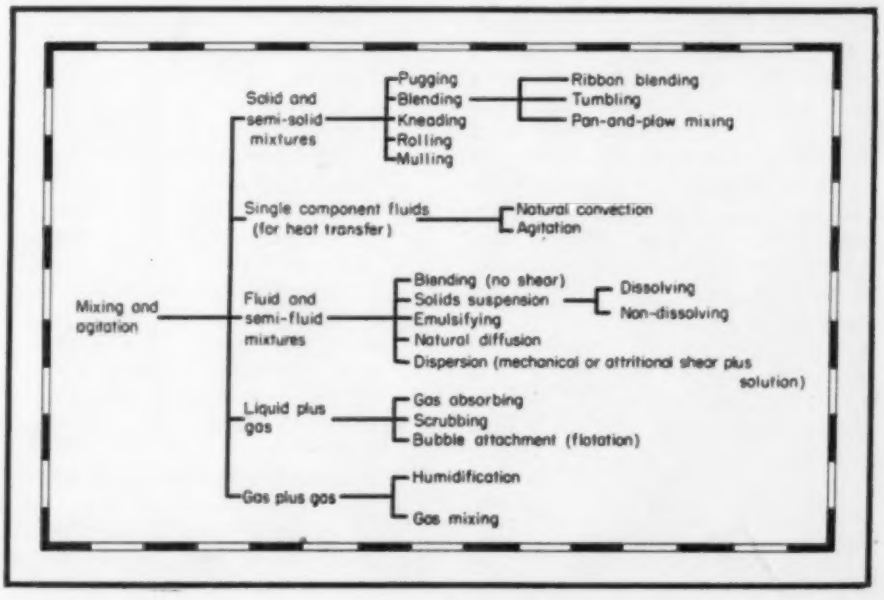
"Blending" has come pretty generally to mean a gentle type of mixing operation in which little, if any, shear and no solution takes place. Dispersion, on the other hand, refers to a more violent mixing involving both shear and solution. Solids suspension deals with a low rate of shear and may or may not include solution. Other terms appearing in the diagram are more specialized and are generally sufficiently descriptive. The breakdown which separates solid and semi-solid systems, from fluid and semi-fluid, is based on a rough classification of equipment types that can be used, which for want of a better criterion appears to be the best way to determine where semi-solid leaves off and semi-fluid begins.

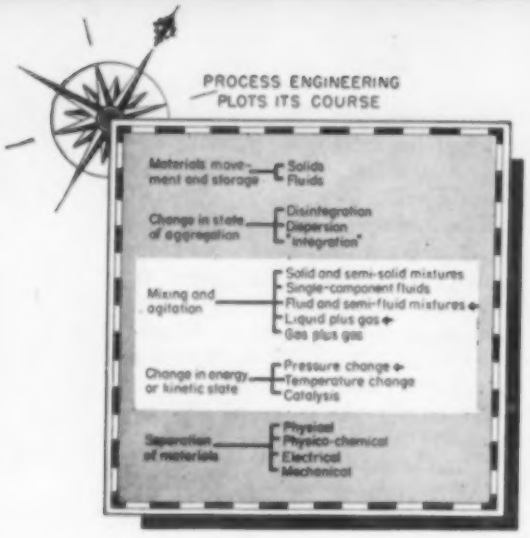
Solid Mixtures . . . . . .

Mixing of dry, pulverized solids has undergone little change in recent years, both ribbon blenders and various kinds of tumbling barrels being used mainly for the purpose. Where such solids are mixed with liquids to produce masses of relatively high consistency, mills of muller or chaser type are chiefly used, and these have undergone considerable mechanical refinement. For example, automatic cycle control has been applied to make possible completely automatic mixing. However, considerable development work has gone into improvement of heavy-duty kneading equipment of the intensive type, used for the heaviest plastic masses, as well as into intermediate-duty, double-arm mixers. Several manufacturers have recently brought out new intensive mixers in response to needs in plastics processing, with particular attention being paid to mechanical design improvements, better cooling, and more efficient types of mixing arms, as well as features to facilitate loading, discharging, and clean-up. Machines of this character are heavily powered, providing in the order of 10 hp. per gal. of working capacity.

A trend in production of synthetic resin enamels is to employ an intermediate-duty, double-arm, dispersion mixer to produce a dense dispersion of pigment and resin without use of ball or roller mills. The dispersed mass can be diluted slightly, discharged and stored as such, and later diluted further to desired final consistency with low-powered agitation equipment.

Double-arm mixers have recently been applied increasingly in continuous processes. In general, such machines take two forms: a cascade





arrangement in which three double-arm machines are arranged on a single bedplate, one discharging into the next lower machine; and an in-line arrangement where, in effect, three machines are joined end-to-end, with through shafts equipped with interrupted sigma blades arranged in a spiral, to mix material in a figure 8 pattern, and slowly advance it from the feed to the discharge end.

Screw-type expeller principles have also been applied recently to continuous mixing in consistencies approximating that of bread dough. Solids and liquids are introduced together into a chamber where they are first mixed by specially designed rotating blades, then discharged by a screw on the same shaft.

Fluid Mixtures . . . . . .

It is in field of fluid and semi-fluid mixtures that great preponderance of chemical engineering attention has been concentrated. Two schools of thought exist among those who devote their time to this matter, the first maintaining that mixing is still an art; the second, that while it is still an art, it is rapidly approaching status of a science. Both schools recognize that a great deal of useful work has been done, but one is more optimistic than the other concerning imminence of ability to design mixers from data correlations and theoretical considerations. Both schools admit that a stage has now been reached when successful scale-ups can be accomplished from laboratory or pilot plant investigations in a great many cases, provided that small-scale data are interpreted with experience. Both admit that mechanical development has reached a high state of perfection and that a large body of information on applications, of a qualitative rather than a quantitative nature now exists.

It has been pointed out that initial development of a unit operation usually involves introduction of equipment which will perform some operation satisfactorily, after which, in the second stage, equipment is evaluated to achieve a more economical result. Mixing appears still to be in early part of the second phase. Much work has gone into efforts to determine power requirements of various mixing systems, and to correlate such power with the job to be done. At this stage the power problem has been largely solved in respect to purely hydraulic aspects of the question, and it is entirely possible to determine in advance what power will be consumed by certain types of impeller in producing a desired liquid flow against a certain head. However, as yet there are no general correlations between energy consumed and flow pattern, on the one hand, and a desired mixing result, on the other.

Mixing Criterion . . . . . .

One of the most essential problems, still unsolved, is to develop suitable criterions for amount of mixing that is needed in a given case. Power alone is apparently not such a criterion since it is not at present possible to predict conditions under which the power will be applied with maximum effect. Parts of the problem are becoming better understood. For example, much has been learned about influence of number, kind and placement of baffles, and effects of tank shape and impeller placement. Recent work indicates present possibility of predicting what baffling will give maximum useful effect. Some data exist in the literature on discharge capacities of certain kinds of impellers, and more is awaiting publication.

Several facts lead to a hope that fairly early solution to many of the problems of mixing will be reached. Much experimental work is now being carried out cooperatively, in industry, at universities, and by mixer manufacturers. A committee on mixing standards has been set up by American Institute of Chemical Engineers, and it is hoped that this committee will assist materially in correlating this effort. It has been suggested that future concentration on a relatively small number of impeller types of more general usefulness will be helpful, thus to an extent eliminating type as a variable, and permitting attention to be directed primarily toward variables of process requirements, impeller size and speed.

It is certainly true that a large number of impeller types are in use at present, some of which are highly specialized and of limited application. Although usefulness of most of these has been pretty well delineated, it is only from a qualitative standpoint that their limits are now known. Furthermore, in most cases, liquid turn-over and fluid velocity patterns produced by these impellers are known only qualitatively. There appears to be considerable merit in concentrating study on a relatively few types.

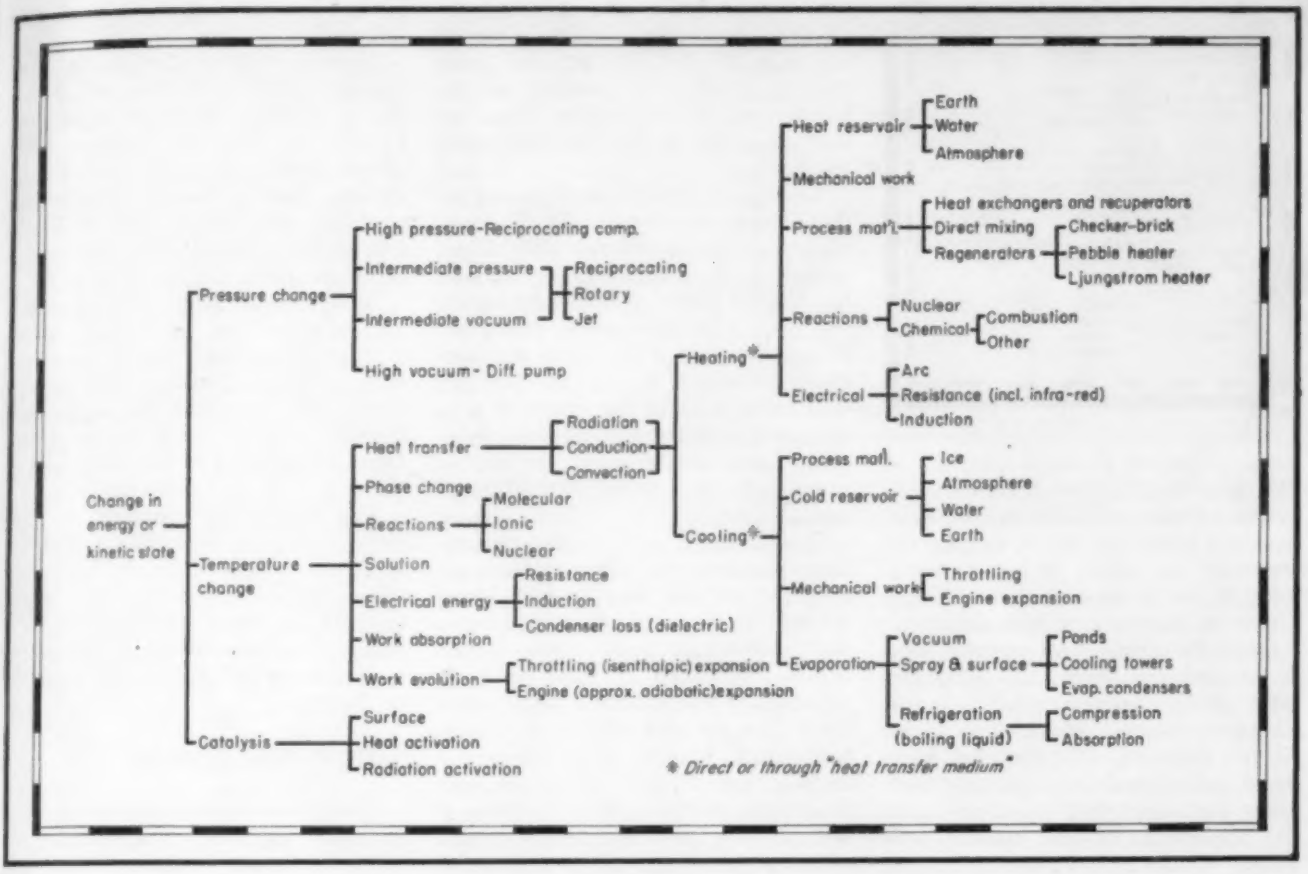
Trend of Study . . . . . .

For the future it can be assumed that effort will continue to be directed toward the primary problem of predicting optimum amount and kind of agitation required for various kinds of mixing problems. Other effort on more special problems will be concerned with securing data on heat transfer in agitation; effect of bubble size and contact time in liquid-gas contacting and characteristics of continuous flow mixing systems which at present are largely without data. Another spot toward which study will be directed is systems of non-Newtonian type, possessing apparent rather than actual viscosity.

Mixer Types . . . . . .

At present it is often difficult if not impossible to decide without experiment which of the various available impeller types will best fit a given case. Many have overlapping characteristics. In addition to paddles, propellers and turbines of more conventional design, several novel impellers have been introduced in recent years which still further tend to complicate matters of choice. Among these is Struthers-Wells' radial propeller, a low-delivery, high-shear type; and the Velofin, also characterized by low flow and high velocity and shear. This machine has the unique property of being readily adjusted in the field. The Cowles dissolver, a moderate-flow, high-velocity, high-shear type is, like the Velofin, driven at motor speed of 1,200 to 1,800 rpm., thus requiring no speed reducer. The Centri-cone, another new type, is a large-diameter, low-speed, high-shear machine particularly suitable for liquid mixtures, and for crystal-containing as well as fibrous slurries.

Although it has long been the custom to regard mixing and agitation as being substantially without scientific basis, and although quantitative data are still relatively scarce, this situation is changing. A concerted drive is under way and mixing may attain predictability of well rationalized unit operations such as heat transfer, fluid flow and distillation before many years have passed.



Changes in Energy Or Kinetic State

IN THE SCHEME adopted here for classification of phenomena that affect the thermodynamic state of processes, it appears that a grouping under pressure level, temperature level, and catalytic operations, is most convenient and logical. Lacking exact knowledge of the mechanism of catalysis, there may be some question as to its classification, but its apparent equivalence to energy change by pressure or temperature makes its listing parallel with these seem reasonable.

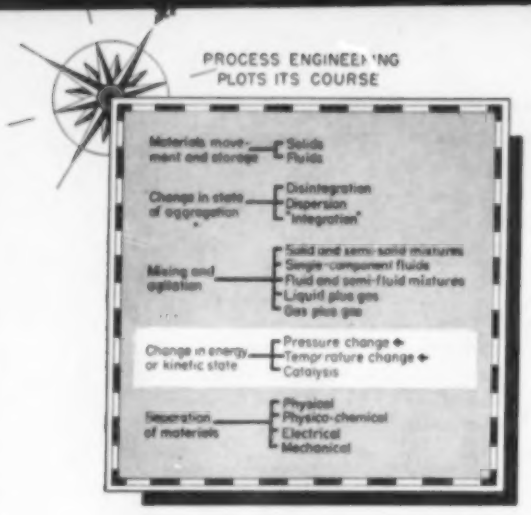
Most previous efforts at unit operations classification have run afoul of difficulty in attempting to say which among the energy change phenomena are—and which are not—unit operations. The present classification deliberately avoids this problem. It makes no effort to distinguish between the unit, and non-unit, operations. Nothing is gained by attempting such a distinction and, in fact, valuable relations may be obscured by so doing. It is sufficient to point out that heat transfer, by whatever method, can still be considered and studied as a unit operation, and that the kinetic effects accompanying pressure changes may certainly be so considered.

Most interesting property of the present classification is its feature of emphasizing whether heat transfer is, or is not, a factor in the energy change. While heat transfer will generally be involved incidentally in both pressure change and catalysis, it is not necessarily present—except incidentally—in cases of temperature change. The distinction depends on whether material being considered gains or loses energy *in situ*, or whether energy must be transferred to or from it by (or through) another medium. A few examples, as illustrated in the chart, make the distinction clear. Energy change without heat transfer takes place when a liquid is cooled by self-evaporation under vacuum, or when a chemical or nuclear reaction occurs. Material may be heated through its own electrical resistance, or by condenser-loss effect in a dielectric heater. It may absorb work—which appears as heat—or it may lose heat by doing work through expansion in an engine. There is of course no implication that energy of the total system is being created or destroyed by any of these processes, but only that it is being changed from one form to another—or from matter to energy in the case of nuclear reactions.

However, in most chemical processing, heat transfer is an essential part of the process. Heat will be supplied by a secondary reaction such as combustion, or it will be recuperated from other process materials, or the same material at some other part of the process. Transfer will generally take place through a wall, through the intermediacy of a heat transfer medium, or by direct radiation from a heated body.

Pressure Level . . . . . .

Carrying out reactions or operations at pressures other than close to atmospheric is usually done because of the chemical nature of the reactants or the equilibria of the system. For example, high pressure favors the equilibrium in production of ammonia and methanol. In production of polyethylene from ethylene it is essential for any reaction to take place. Ultra-low pressures, on the other hand, are generally used be-



cause of lack of chemical inertness of the chemicals concerned. Hence high-vacuum processes usually involve heat-sensitive materials. Ability to raise the volatility, in effect, at low temperatures by use of vacuum is the primary virtue of high-vacuum techniques.

High Pressures—Top pressures used in commercial chemical operations have slowly been creeping upward. However, increase in use of pressures of the order of 350 atm. has been rapid. In extremely high-pressure work there have been two major divisions: (1) Application of new chemical syntheses which require high pressures, and (2) development of new techniques for fabrication of pressure vessels.

Commercial pressures of 700-1,000 atm. have been used since the middle 1920's in synthesis of ammonia and methanol. Until recently, these and similar processes represented probably the highest regular operating pressures. Wartime development of polyethylene, regularly produced at pressures as high as 2,000 atm., has greatly boosted this limit. There are indications that new plants for other products may go in at similar pressures, and pressures as high as 4,000 atm. are a near-future commercial possibility.

In the 500-5,000 psi. range, plants and processes have increased rapidly. Many new petroleum alkylation and polymerization techniques are working in this intermediate pressure range, as are several hydrogenation processes. Expansion of ammonia and methanol capacity has meant many new plants at 5,000 psi. With many more companies now familiar with such pressures, probability is that more research work is being done in what used to be considered the very high range.

From an equipment standpoint, the higher pressure trend can be seen in standardization of equipment for the higher range. Where pumps and valves used to be special jobs for such pressures as 5,000 psi., standard designs are becoming available. One of the biggest jobs for extreme pressures is satisfactory packing design. Much work is being done, aided by German efforts in the 500-1,000 atm. range.

Vesselwise, newest development is the German strap-wound vessel which, somewhat similar to the multi-layer, shrunk-on shell construction used in the United States, promises to undercut cost of forged vessels. Tapes are wrapped around a thin core and prestressed inward to set up tension, idea being to have the vessel at rest, strainwise, when at full operating pressure. Experimental work on this is at present being started in the United States.

In small-scale experiments, tremendous pressures are being developed; even the 100,000 atm. range is being actively investigated. But it appears that much time must elapse before commercial plants are built for these pressures. There are three major problems: The gas permeability of metals, particularly to hydrogen; fatigue of metals; and critical nature of heat treatments involved. So it looks as if several steps will take place before 100,000 atm. is reached commercially. Next step ahead should be in the 4,000-5,000 atm. range.

High Vacuum—High-vacuum techniques, much discussed these days, are moving on into continuing new applications. Perhaps biggest possibilities are in large-scale distillation of high molecular-weight materials and in sublimation. So far, equipment used is relatively small, but both equipment and uses are growing fast.

Technical information necessary for design of high-vacuum equipment is on fairly firm ground, although little of it has been published. Most data reside in files of companies specializing in this field.

Aside from pumps and auxiliaries, new equipment is coming slowly. Most of it is for distillation, (e.g., the Bowman still, treated in more detail elsewhere). Other than in distillation, falling film type units are being used on a large scale for concentration of liquids such as citrus juices and in the production of soluble coffee. Feed capacities of falling film units have been reported as high as 2,000 lb. per hr.

In concentration, and also drying, the importance of the refrigerated condenser may be noted. By freezing out vapors ahead of vacuum producing equipment, the volume handled is cut down enormously. Such a condenser, actually an oversize cold trap, has a rotating condensing surface which is continuously scraped free of ice with blades. Ice removal is required only intermittently.

Next biggest application for high vacuum, after distillation, will probably be various sublimation techniques. During the war the Pidgeon ferro-silicon process for production of magnesium directly from dolomite was operated on a large scale. Sublimation ought to be applied to purification of chemicals as well as metals.

Along this line, high vacuum is finding increased use in casting, where evacuation of a melt gives non-porous, purer castings. Coating surfaces with metals and chemicals like magnesium fluoride is also finding increased use. Here the material to be coated acts as the condenser in a sublimation.

Vacuum drying continues to find interest in food dehydration. Interest in freeze drying seems to be falling off, since solvent drying also seems to work for many materials. Further, many of the supposedly heat-sensitive materials can withstand other methods of drying.

Temperature Change . . . .

Control of temperature is involved in more operations and reactions of interest to process engineers than any other controllable condition. As already mentioned, control is achieved in the majority of cases through exchange of heat energy with some other part of the system, so that the first consideration is heat transfer.

Heat-Transfer Theory—Like work in pressure, heat-transfer investigations are tending to swing away from close-to-atmospheric conditions. Most active work now is with very high temperatures, leading toward high flux, and heat-transfer rates as high as several million Btu. per hour and square foot. This compares with modern boilers which operate at a maximum of about 130,000 Btu. per hour and square foot. Applications aimed at are rockets and nuclear piles, so many of the results are still under cover.

Most high-flux investigations deal with nucleate boiling, where boiling occurs at active nuclei rather than in film form across the full face of the hot wall. Highest heat-transfer rates seem to be found when the main body of cold liquid is below the boiling temperature, the hot side above boiling, and nucleate boiling occurs on the hot wall. With increase in hot wall temperature, the flux increases until a partial vapor film forms on the hot surface, lowering the heat transfer rate.

Another direction of attack on high flux is pressure. Cichelli and Bonilla highlighted this work by finding that highest flux occurred when pressure

of cold liquid was one-third of its critical pressure.

From a design standpoint, design data for exchangers involving no change of phase are in good shape. No experimental work is necessary to achieve satisfactory design unless very high viscosities or abnormally low flow rates are concerned. Calculations for exchangers involving change of state, i.e., condensers and reboilers, are not in similar shape. Experimental work is almost always needed to aid design.

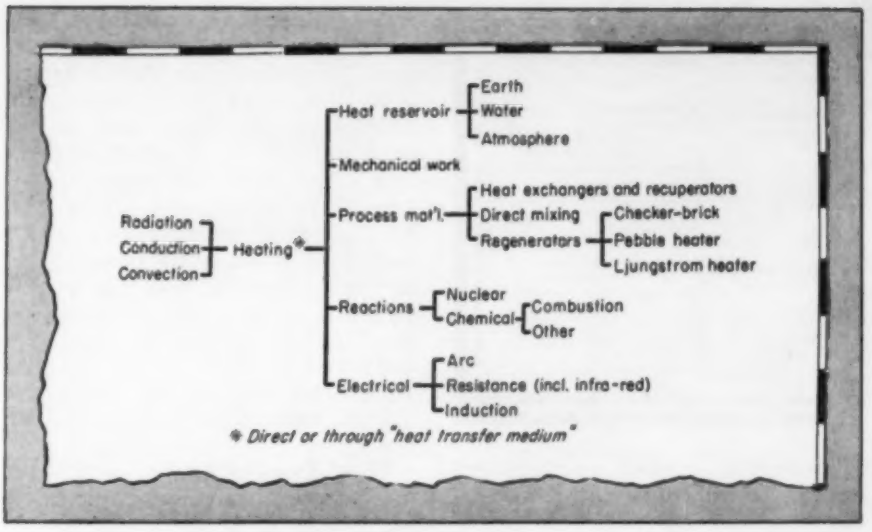
First extended fin surface for low-pressure oxygen units was the Collins exchanger, where elements were in tubular form. Today most effort on such exchangers seems to be on rectangular or hexagonal cross-section shapes. Probably the most troublesome problem is construction, which requires brazing of a very large number of thin sectioned metal stampings into a strong, completely bonded, multi-passage unit.

Also a gas-gas exchange job, considerable effort is being aimed at satisfactory exchangers for use with gas turbines. This problem is simplified one way since need to prevent migration of solidified impurities is missing. But it is complicated by the high-temperature requirement. Most current gas turbine installations are not closed cycle nor do they use heat exchangers. Development of low cost exchangers for this service may cause the trend to go the other way.

Considerable interest is being generated in the Southwest in use of air-cooled exchangers having fin tubes and fan-driven air blasts. In some cases they tend to replace more conventional water-cooling towers. Where water is short, surface cooling by air saves evaporation.

Another trend is increased use of mechanical aids to heat transfer. The Votator is an outstanding example. Core-busters to increase turbulence and heat transfer rates are finding more use in gas-gas recuperators. Standardization of heat exchangers is becoming more important, particularly for those of corrosion resistant construction. Such materials as Duriron, various stainless steels, and tantalum are now built in standard sizes, with resultant savings in price.

Another phase of heat level being actively investigated is the very low range, below 4 deg. K. This work has been greatly aided by development of the Collins helium cryostat. By use of helium as the working fluid, with heat exchangers and an expansion engine, a cold chamber can be cooled for experiments as low as 2 deg. K. Expansion of this work is indicated by the fact that in only two years the number of laboratories investigating such low temperatures has risen from two to twelve. So far, work is entirely long range, like the extreme high pressure investigations. But years ahead may well show practical results.



Heat Increase . . . . . .

Heating—As our chart indicates, five general methods provide heat to processes: Exchange with a reservoir of heat such as earth or atmosphere; absorption of mechanical energy; transfer of heat from a hotter material in process; transfer from a reaction such as combustion; and use of electrical energy. In practically every case some form of heat exchanging equipment is important to the process.

Heat Exchange—Most active work on heat exchangers deals with low temperatures, primarily for production of low-purity oxygen. For more normal pressure and temperature ranges there has been extension of use of finned tubes, finned both externally and internally. In the main, types of heat exchange equipment used are well standardized, new units being merely modifications of conventional units.

Exchangers for oxygen plants have four requirements: (1) Large surface per unit volume, (2) lack of migration of liquefied and solidified impurities, (3) low pressure drop, and (4) low cost. Costwise, they have to compete with regenerators and a real difference of opinion exists relative to the economics of the two.

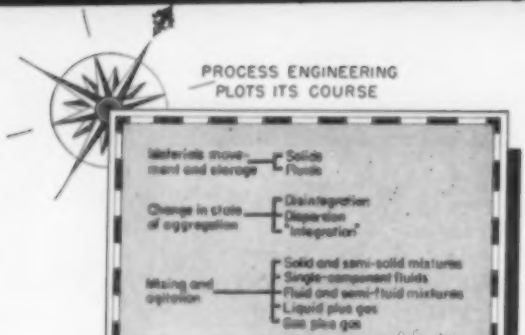
Of the oxygen plants going in for Hydrocol process use, one will employ regenerators and the other, exchangers. Regenerators are also being used in oxygen plants being built by Stacey-Dresser for McCarthy Chemical and by Airco for Bethlehem-Koppers.

However, exchanger design is being actively attacked. Rumors are that two companies will soon announce radically different heat exchangers, probably both for oxygen. Another exchanger being investigated is the Gianque-Hampson, a series of concentric tubes wound about a central core. The tubes are so arranged that each tube, despite its length, has the same pressure drop. The second fluid flows across this spiral of tubes.

Radiant Heating and Cooling—Whereas heat exchangers in usual sense transfer heat mainly by conduction and convection, there is increasing interest in radiant transfer for certain purposes. Radiation cannot, of course, be excluded entirely in conductive and convective transfer and it is in fact an important element in furnaces and all heating operations dealing with high-temperature heat sources. However, emphasis is now being put on radiant transfer, largely without conduction and convection, for such applications as space heating and drying of coatings. Panel heating has made considerable recent strides in both residential and industrial construction and study is now being given to possibilities for panel cooling.

So-called near infra-red heating is becoming standard practice in the industrial baking and drying of finishes, although its use is much less spectacular in drying of other materials. It has been applied successfully in a variety of powder drying applications, including both chemicals and gun powder, and in food dehydration. Considerable study is in progress and continuing improvement in understanding will doubtless overcome much resistance now encountered.

Radiation is also playing an increasingly important part in heat transfer at higher temperatures, for example in modern designs of pipe still furnaces.



Considerable interest has been evidenced in British literature over infrared as a method of liquid heating, using glass or silica piping which is transparent to radiation. With heating lamps of types now available it is claimed to be possible to transfer nearly 4,000 Btu. per hour and square foot, and this figure may be still further increased.

Heat Regeneration—In operations where heat is to be transferred from one process gas to another, for example, from flue gases to combustion air, regeneration is often more satisfactory than recuperation, i.e., transfer of heat through a surface. The checker-brick regenerator, an old tool for this purpose, suffers from the disadvantage of being discontinuous. First successful continuous regenerator was the Ljungstrom preheater, which has required little modification since early designs. It has found increasing use in chemical processes, in addition to its primary field in power plants. Since it is not suitable for extremely high temperatures, being of metal construction, the checker-brick regenerator retained its hold for high temperature uses. A few years ago pebble heaters made their appearance for still higher temperatures. Initially discontinuous, this device was modified by Babcock & Wilcox Co. to give continuous countercurrent performance in preheating air for high-temperature combustion operations and producing extremely high-temperature process steam.

At present research is continuing on both equipment and its applications, although new uses are not yet ready for announcement. It is possible, for example, that pebble heaters may find use in the direct nitrogen oxidation process developed at the University of Wisconsin, a process now reported to be undergoing further development by Food Machinery Corp. A pebble heater was initially used at Wisconsin in producing air temperatures high enough for direct union of nitrogen and oxygen.

Another use for regenerators, already mentioned, which has recently assumed importance in United States, is in low-pressure oxygen production. The Fränkl regenerator used in the German Linde-Fränkl process has now been employed in one low-purity oxygen plant built here and it will be applied in at least two others instead of more costly reversing exchangers. This regenerator is a vessel packed with aluminum spirals and has the dual function of transferring heat and freezing moisture and carbon dioxide from the incoming air. Like checker-brick regenerators it is discontinuous.

Heat Transfer Media—Several developments in heat transfer media are of current importance. Interest in mercury for industrial heat transfer appears now to be static and to be limited to power production. Hot oil has decreased markedly in use, most of its former applications having been taken over by Dowtherm which has expanded to a remarkable extent. Somewhat surprisingly, there has been a rebirth of interest in circulated high-pressure water, influenced no doubt by the considerable respect which this method gained in Germany.

Some of the secret work being carried on in connection with atomic power production is known to be directed toward heat transfer media. It is believed, for example, that at least a part is concerned with metal eutectics. Meanwhile, the long-rumored tetra-aryl silicate is being introduced to the market. Even steam, the old stand-by, continues to be investigated.

Dowtherm units have not changed much in several years, except that they are being built both larger and smaller. Some smaller units now employ an integral vaporizer built into the vessel jacket and provided with electric heating elements.

Several pressure water systems are now available, generally for use with an existing boiler from which water is withdrawn by a pump at superatmospheric pressure and at any needed temperature up to about 400 deg. F. (250 psia.). Smaller pipes can be used than with steam, traps are unnecessary and pipes may be run in any direction, without consideration to pitch. Savings are claimed by virtue of lesser pipe wall area through which radiation losses can take place, a factor which allows heat to be transmitted over relatively long distances. Feedwater treatment and boiler blowdown are practically eliminated, since virtually no make-up is required.

Bethlehem Foundry, in cooperation with Du Pont, has introduced a packaged unit for high temperature heating with a molten mixture of 50 percent each of sodium nitrite and potassium nitrate. This mixture, Hi-Tec, melts at about 282 deg. F. and so must be circulated from a heated storage tank, but it can be used in steel to about 850 deg. F., and in stainless steel to 1,000 deg. F., or even higher. Complete units comprising furnace, circulating tank, pump and all controls for automatic operation are now produced in sizes from 500,000 to 2,500,000 Btu. per hr.

Tetra-aryl silicate, a development of Arthur D. Little, Inc., is like molten salt mixtures in that it is liquid (or, rather, a family of liquids) at the temperatures for which it is now being sold. It has the same operating temperature limit as Dowtherm, 650 deg. F. at present, but its pour point is −45 deg. F., and it is being researched to the 800-850 deg. F. range. Viscosity is low enough for centrifugal pumps, and the material does not leak readily through joints. Commercial development of the compound has been put in the hands of Hodges Research & Development Co., while it understood that equipment for its use is to be produced by Surface Combustion Co.

Some further development in use of flue gas for heat transfer has been evident. Since principal objection to direct firing is usually problem of temperature control, or of avoiding excessive temperatures, a solution used increasingly is to recirculate a part of the flue gases to exert both a flywheel and a depressing effect on temperature level.

Heat Release Equipment—With sharp increase in fuel costs in recent months, interest in better and more efficient combustion methods continues. There appears to be some tendency, for example, for kilns to become still longer and one manufacturer now offers rotary kilns 500 ft. long and 12 ft. in diameter. At the same time, heat recovery is becoming more essential and product coolers are assuming greater importance. Hence, too, large kiln users are paying renewed attention to heat recovery at the opposite end of the kiln, namely, to waste heat boilers operating on exit gases.

A very interesting development in boiler furnaces which may have possibilities for other purposes is the "cyclone" furnace recently perfected by Babcock & Wilcox. Since boiler users can no longer be sure of securing best grades of coal, this furnace was deliberately designed to produce a molten slag with high-ash coals of low fusibility. It consists of a water-walled cylinder, closed at one end, opening at the other into a water-walled com-

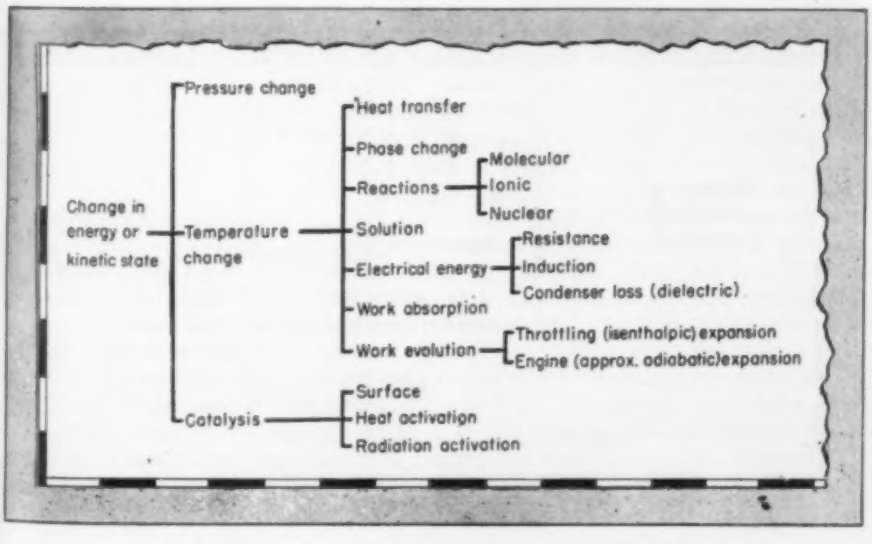
bustion chamber of a normal boiler furnace. With its axis sloping slightly downward toward the combustion chamber, it discharges a continuous drip of slag. Coal, crushed in a hammer mill but not finely pulverized, is introduced with air through a tangential inlet at the rear, with some particles burning in suspension, others burning trapped in the molten layer of slag coating the cooled wall. It not only burns high-ash coals successfully but is said almost to do away with need for flyash collectors.

Heat Pumps—Neatest recent way of lifting oneself by one's own boot straps is the heat pump, an old thermodynamic idea now come into prominence in at least two different guises. Whereas Maxwell's hypothetical "demon" and the Hilsch "vortex" are able only to separate the "hot" molecules in a gas stream from the "cold" ones, heat pumps at first glance appear to create hot molecules from cold ones for the expenditure of one-third to one-tenth their value in mechanical or electrical energy. This feat is simply that of raising low-grade heat in a vapor to a higher level by mechanical compression. It is physically identical with ordinary compression refrigeration cycles. All that is necessary is to change one's point of view and consider condenser as heater, and evaporator as heat source. Then it becomes clear that heat of vaporization, picked up at a lower temperature in the evaporator, is then delivered at higher temperature by condensation in the condenser, along with heat equivalent of energy of compression. Thus anywhere from about three to as much as ten (or more) times the compressor energy, becomes available as heat in the evaporator.

In one guise, the heat pump has blossomed out as the vapor recompression evaporator, well known to military personnel during the war as the Kleinschmidt sea water still. Its reported performance in that service was equivalent to a 15-effect evaporator with but a single evaporator body. First advocated nearly 100 years ago, the method has frequently been tried in the past but has generally failed to justify itself, either because applied to solutions having too great a boiling point elevation, or because too expensive compression equipment was used. For non-scaling liquids of little boiling point elevation it appears to offer possibilities with modern low-ratio compression equipment. Development of such applications seems to be going actively ahead.

More dramatic possibilities reside in heat pumps for space heaters, especially where heat requirements are not severe, and considerable summer cooling is desired. Not new, this application has recently flared into prominence and is now pushed actively by several commercial interests. As heat source, the atmosphere, waste liquors or sewage, ground waters, or the earth itself can be used. The higher the source temperature, the better. Beauty of this system in not too severe climates lies not only in the fact that electric heat can be secured for expenditure of about one-third to one-sixth the requirements in compressor power, but also that connections can be reversed immediately to provide cooling instead of heat. A similar system can provide process heat from any low-grade heat source, such as a waste effluent.

Change Without Transfer—Although indicated separately in our chart, most methods of producing temperature change without heat transfer, by producing the change directly within the process fluid, are exactly comparable to methods used with separate heat transfer media. Thus they include phase changes such as evaporation, condensation and crystallization; reactions of both chemical and nuclear varieties; solution with or without phase change; and evolution or absorption of work energy.



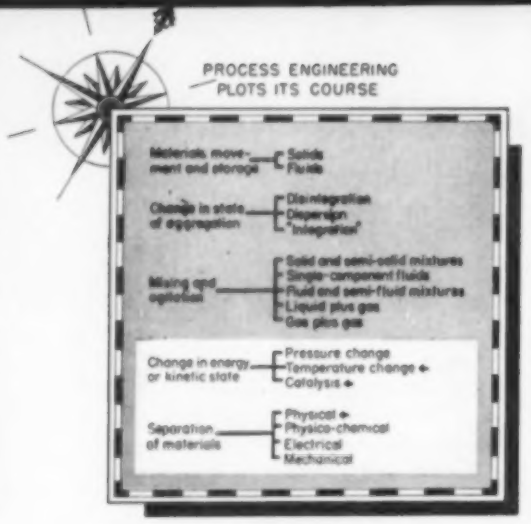
Temperature Reduction . . .

Process cooling can be accomplished by heat exchange with colder bodies, such as another process fluid or a cold reservoir, by methods exactly similar to those already mentioned under "heating." Or, a heat transfer medium may itself be cooled by a thermodynamic process and then used in heat exchange relation with the process fluid. These thermodynamic processes include expansion and evaporation.

Expansion—Only recently have expansion processes for cooling (without evaporation) come into much prominence, with sudden blossoming of interest in tonnage oxygen for fuel and metallurgical industries. Two expansion processes are employed, the Joule-Thomson or isenthalpic, which obtains expansion through a valve or orifice; and the approximation of adiabatic expansion resulting when expansion does work in an engine. Since considerably more refrigeration results from the latter, there has been much recent interest in development of centrifugal expanders that come as close as possible to the desired adiabatic line. In oxygen processes, of course, the medium expanded is generally air itself rather than a separate heat transfer medium.

Evaporation—There is no fundamental difference whether a process liquid is cooled by its own evaporation, or by that of a heat transfer medium in heat exchange contact with it. However, cooling by vacuum evaporation of the process fluid itself is commoner than cooling a transfer medium (such as water) by this means. Vacuum refrigeration of process cooling water has not made the progress that was expected of it a few years ago, whereas vacuum cooling of solutions in crystallizers is extensive, and a continued increase is noted in certain other vacuum cooling applications, such as mash coolers. Steam jet ejectors have made both such applications possible.

Cooling Towers—Spray ponds, cooling towers and evaporative condensers and coolers have all become more essential as cooling water loads have grown while suitable cooling water has become more difficult to secure. However, since ponds are wasteful both of space and of water, towers and evaporative condensers and coolers have tended largely to replace them. Sim-



ilarly, mechanical-draft towers are replacing the natural draft variety, largely because of need for closer water temperature control. Refinements in air and water distribution, better fans and nozzles, prefabricated construction, and effective treatments to avoid fungous and algal growths in the tower, are all developments of recent years, as is the growing custom of placing process piping to be cooled in the tower bottom instead of in some remote heat exchanger to which circulating water is pumped. On the design side, design is now largely based exclusively on heat as the driving force. Slat arrangements for tower packing are now similar to staggered tubes in heat exchangers to secure higher heat transfer rates and a more compact apparatus.

Refrigeration—This term is reserved here for cooling processes in which a heat transfer fluid is compressed, cooled and condensed, and its liquid evaporated at lower pressure by withdrawing heat from the process being cooled. Although it appeared a few years ago that absorption refrigeration might be staging a come-back, this is evidently not true. Absorption offers advantages, especially where waste heat is available, but equipment is expensive compared with compression refrigeration. Most important present trend is toward use of centrifugal compressors for all sizes from about 200 tons capacity, up. Freon is largely replacing other refrigerants. In units of lesser capacity, V-type compressors operating at speeds up to 1,200 or 1,300 rpm. are tending to replace low-speed (400 rpm.) compressors formerly standard. V-type has been simplified from a maintenance standpoint, provided with fewer piston sizes, and generally designed for flexibility in arrangements to provide for varying capacities. In special field of ice making, particularly for industrial and commercial purposes, present tendency seems to be toward use of automatic ice-making machines, such as Flak-Ice, Tube-Ice and Pak-Ice machines, rather than conventional can processes.

Catalysis . . . . . .

That catalysis is still an art was aptly put by Krase when he said "Catalysis is a designation used in lieu of scientific information." Slowly, however, scientific background is being developed. Most recent developments in catalysis have to do with technique and materials, rather than fundamental knowledge. Chief among these have been fluidized catalyst technique and use of ion-exchange resins as catalysts for esterification reactions.

Problems of real understanding in catalytic action require knowledge of six rates: (1) Solid-fluid mass transfer rate, (2) internal diffusion rate, (3) chemical reaction rate, (4) heat dissipation rate, (5) thermal conductivity of the catalytic bed, and (6) eddy diffusivity in the bed. To exemplify distance science has still to go in catalysis, the only one of these rates well covered is chemical reaction rate. On the others available data are either meager or entirely lacking. Much work is going on, however, and some of these problems will be solved. We can expect to see some radically new concepts of catalysis come out this summer.

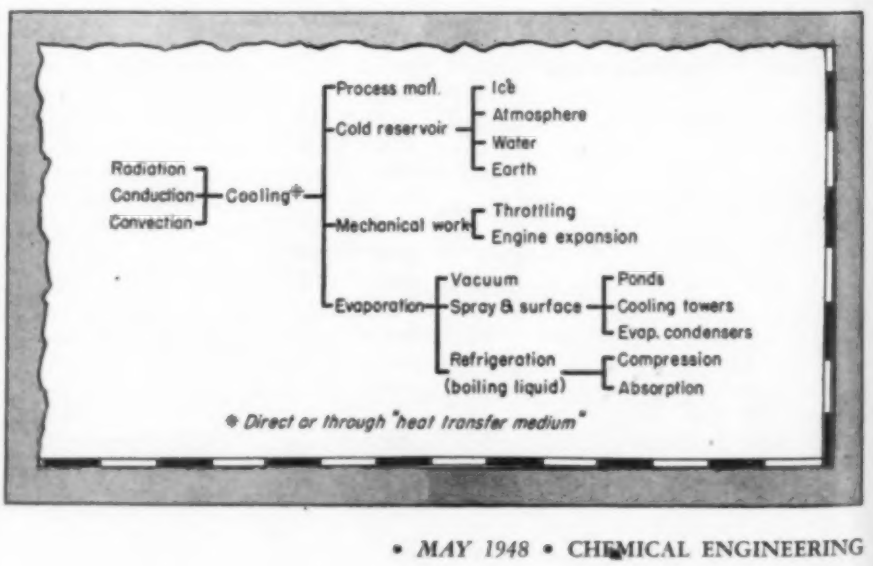
Despite lack of fundamental data, search for better catalysts goes on empirically. Improved promoters, basic oxides, and new metals continue to be investigated. New availability of some of the rarer metals has attracted increased interest in their use as catalysts.

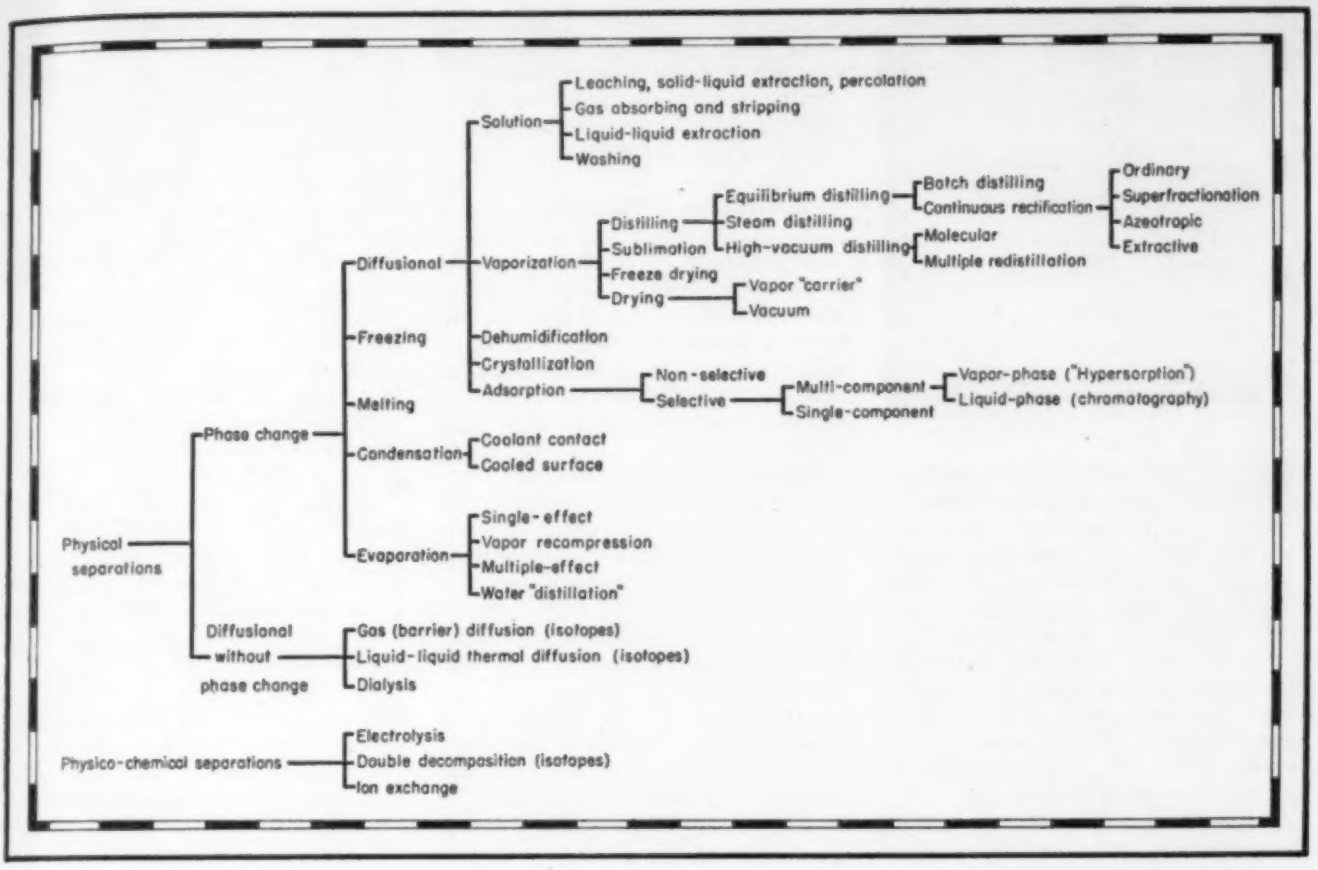
Fluidization has proved a happy medium for catalysis, and first materials so handled were fluid catalysts. Fluidization is treated more fully on page 125. From a catalytic standpoint, newest thing in fluidization has been production of new synthetic fluid catalysts. Labeled microspheroids, these tiny, round particles of alumina are claimed to suffer less from attrition and to flow better than ground natural catalyst. Their impregnation with metal catalysts is possible for systems other than those catalyzed by alumina itself.

TCC technique has received aid from synthetic catalysts, too, in this case synthetic silica beads, containing the active alumina. Highly porous, such beads have tremendous surface area and low resistance to fluid flow. This general form of catalyst should grow in use as the moving bed system expands its fields of application.

Newest generic type of catalyst is the ion-exchange resin. Standard technique for esterification is to mix and heat the alcohol and organic acid with sulphuric acid as catalyst. Later the acid has to be neutralized before purification of the ester by distillation. Leaving out acid and adding an acid form of cation exchanger gives the same catalytic effect, saves neutralization, and can be reused indefinitely. Moreover, it is claimed that the product ester has better color. This one use of ion-exchange resins points up possibilities for these resins in other cases where acids or bases are used as catalysts.

Catalysis by electric discharge continues to find interest. In particular, use of "crossed discharge" for the fixation of atmospheric nitrogen is being actively investigated. Although it is not now being talked about publically, this looks like the best bet for direct production of nitric oxides from air. Long dreamed of, other processes have been promoted, notably the arc process. In general, those tried have proved uneconomic; this new catalytic method may do the trick.





Physical Separations

MOST NUMEROUS of all unit operations are those in the general category of separation. For purposes of classification they have been broken down here into four main groups: physical, physico-chemical, electrical, and mechanical separations. In the first group, physical separations, most involve a change in phase as the chart shows and in many molecular diffusion is a controlling factor. Some of the most interesting recent advances among all unit operations have occurred in physical separations, notably, in distillation and in selective liquid-phase and gas-phase adsorption.

Solution Operations . . . .

Leaching and Solvent Extraction—Development in leaching has been largely related to equipment improvements. In heavy leaching, especially work on minerals, these improvements have taken the direction of better agitating equipment, and design advances in filtering and classifying equipment. In leaching of sugar from sugar beets, a number of plants have substituted continuous equipment for batch-type countercurrent "diffusion" cells customarily used. In several leaching operations pH control is found a determining factor and has received considerable study. Such control appears to be particularly important in purification of gels during manufacture, for example, silica gel.

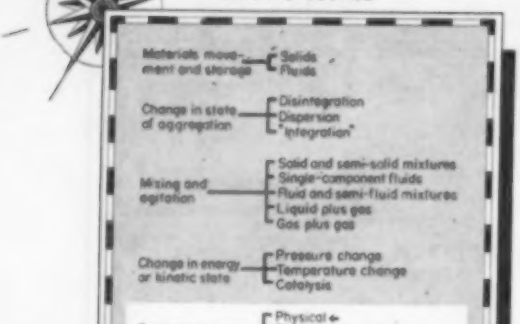
Solvent extraction for recovery of oils from oil-bearing agricultural products has made continued progress and is taking on increased importance in such fields as cottonseed, soybean, tung and linseed oils. Substitution of extraction for cooking and pressing, or addition of extraction to preliminary pressing as circumstances may warrant, has not only a beneficial effect on operating cost from a labor-saving standpoint, but also can be relied on to produce an equal or superior product at higher yield. First full-scale continuous solvent extraction plant for cottonseed, which went into operation in 1947, produces about 45 lb. more oil per ton of seeds than by straight pressing. Tendency is away from chlorinated hydrocarbon solvents, with hexane currently favored. This results in some fire hazard, which has considerable influence on plant design.

There is, for example, a tendency toward outdoor plants so far as climate will permit in a process which of necessity involves considerable solids handling.

Most critical step in such processes is the extraction proper, to which much attention has been devoted. Countercurrent movement of solvent and solids is necessary and current practice seems to favor methods in which gentle agitation can be combined with a small amount of mechanical pressure to induce "sponge" action, as exemplified particularly in the Kennedy process.

Gas Absorption—This operation remains a subject of study, although less work apparently is being done at present than in the past. New packings have been introduced and some valuable theoretical work has facilitated calculation of number of theoretical trays required in multi-component, high-pressure absorbers. Further effort has gone into determination of flooding velocities, which now seems to be pretty well in hand. Some study has continued on film coefficients and mass transfer; however, predicting "height of a transfer unit" still has not reached a general solution.

One interesting trend in absorption



is increasing use of agitated-vessel type absorbers, instead of packed columns. Another is greater application and standardization of corrosion-resistant materials of construction. Tantalum and Karbate are finding increasing use, for example, in small standardized units for HCl absorption that have been applied extensively in recent years. A new type of tower which is generating some interest is the cyclone spray tower, the big advantage of which is low pressure drop.

Liquid-Liquid Extraction — Long considered as a last resort, liquid-liquid extraction may get a lift from new extraction column designs being pilot-planted today. One of these is the Scheibel column, illustrated here. This is expected to reduce HETP's on large industrial-scale columns from roughly 10 ft. to 1 ft. Small-scale units have given a 2-in. HETP. The principle appears to be excellent dispersion given by agitator paddles, the dispersion being almost an emulsion which exists well into the packing. Packing is a woven wire mesh, matted before installation in the column. One unknown is the through-put capacity of such columns.

For years the theoretical value of liquid-liquid extraction has been recognized, but poor efficiency of available columns has limited commercial use. New columns may change this picture, so general fields of application for extraction should be noted. They include: (1) Separation of chemicals where there is little difference in relative volatilities; (2) separation of non-volatile and/or heat sensitive materials; (3) recovery and concentration of chemicals from dilute solutions; (4) removal of impurities and color bodies; (5) recovery and purification of pharmaceuticals; and (6) treatment of liquids containing gummy solids.

In many of these applications, liquid-liquid extraction has to compete with other separation methods. In the past, with its handicap of poor column efficiency, it has been applied to only a few new processes on a large scale, notably furfural extraction of lube oils and the Solexol process for refining natural oils. The Podbielniak centrifugal contactor is being used to a large extent on penicillin.

Vaporization Separations . . .

Vaporization forms the basis of a considerable group of separations of which distillation, drying and evaporation are most important. Since diffusion is of importance in the first two only, they will be considered in this section, with evaporation at a later point.

Distillation—Like many old unit operations distillation's more normal forms continue to advance in technique and application without making much fuss. More unusual methods and equipment are of most interest. Greatest interest today in this operation is focused on extractive and high-vacuum distillation.

Background material available for design is quite complete for high-temperature equilibrium distillation. Basic research work may have reached the point of diminishing returns. Missing, and badly needed, however, are more data on plate efficiencies achievable in industrial columns, and a real method of predicting efficiencies. Two trends are visible in high-temperature distillation. The first is closer design of columns, leading to smaller units with less safety factor. The second is growth of so-called superfractionation which gives results similar to continued batch redistillation by use of very high reflux ratios and columns with as high as 100 or more plates.

Extractive distillation has made great strides recently. Biggest coming application will be in separation of chemicals from Fischer-Tropsch synthetic fuel units now being constructed. Extractive agent will be water, which is cheap, available, and effective. In production of butadiene and toluene, extractive distillation gave higher purity products than any other process. Extractive distillation with furfural of C_4 hydrocarbons is another application.

One interesting application has been purification of grain alcohol by extractive distillation with water in a Vulcan conical spray tower. Tower feed consists of mixed heads, ethanol, and amyl alcohols as tails. By injecting 90 deg. F. water into the column the amyls are extractively carried overhead along with regular heads. Material which boils in the middle—the ethanol—becomes the tails product, both high- and low-boiling components having been removed overhead.

High-vacuum distillation has made great strides in recent years. Newest development in so-called molecular distillation is the Bowman still, consisting of a heated cylindrical wall with a cylindrical, rotating condenser inside. Its tremendous advantage is that it brings reflux and fractionation into high-vacuum distillation with a separation effect of up to 18 plates at 200 microns pressure drop.

The Hickman centrifugal molecular still continues to find its biggest application in vitamins where heat sensitivity is at its highest. Although it normally has a separation efficiency of only one plate, this is being offset by staging units.

Falling-film type stills have been built for rates of feed as high as 1 ton per hour. Biggest application so far is in distillation of plasticizers. Other fields include waxes and lubricating oils. Distillation rates are as high as 60 lb. per hr. per. sq. ft.

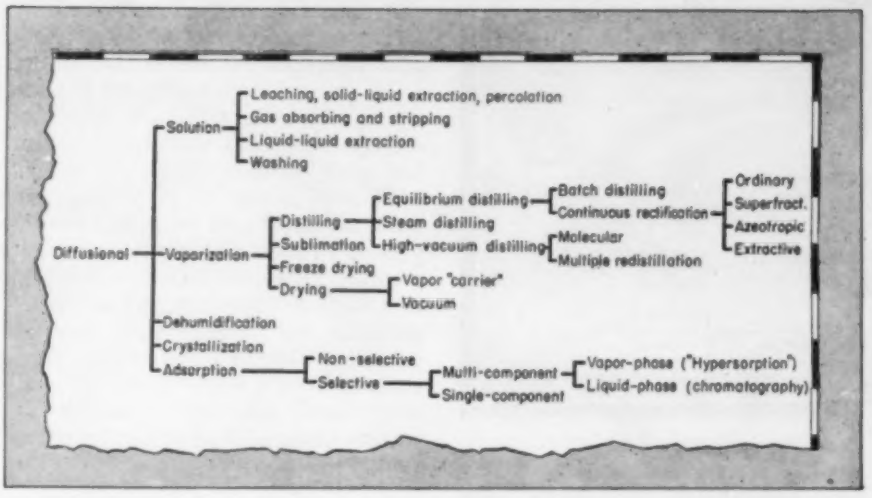
Of various high-vacuum stills, the one which should make the next commercial dent is the Bowman still. So far only small-scale units have been built, but scale-up does not appear to be too much of a problem and, in fact, will overcome certain difficulties met in design of smaller units. So far, also, all these stills have been operated as batch units. Next move will make them continuous, with feed half way up the column. Such a course will cut down heat decomposition as well as decrease cost of operation.

Sublimation — Vaporization from the solid state has recently come in for increased attention for purifying chemicals, largely through development of a continuous sublimer which can be operated in a closed system with a condenser, using any desired kind of atmosphere. This machine, a modification of the Turbo dryer, has heat supplied both to the recirculating atmosphere, and by means of heaters and recirculating fans within the sublimer shell. Such materials as naphthalene would appear to be best suited for purification by this means.

Although it has not yet been tried, similar equipment has been considered as a means of subliming sulphur in an SO_2 atmosphere, for subsequent mixture with air and combustion, for sulphuric acid manufacture. The usual burner would thus be eliminated.

Freeze Drying—This operation, actually sublimation of water from the frozen state for dehydration of extremely heat-sensitive materials such as blood plasma and penicillin, was applied extensively during the war and became a large-scale application for high vacuum. Thermal damage, of course, is a product of both time and

temperature and in freeze drying temperature is much reduced at expense of time. At present some thinking appears to be tending away from freeze drying, securing necessary safe thermal exposure by higher temperature, but shorter time. Vacuum still plays a part in order that continuing vaporization may take place. At this point it is too early to predict which school of thought will prevail. Freeze drying is costly, but it has a number of unique advantages apart from thermal exposure, and in some sorts of application these other advantages may swing the scales.



Drying—Such a diversity of equipment exists for drying that choice of the best method for any purpose in many cases becomes extremely difficult. As a first approximation dryers can be classified by their means of removing moisture after it has been vaporized from the solid: that is, whether moisture is "pumped away" by evacuation, or carried away mechanically by flow of a carrier gas such as air. Further classification is very complex. Up to this point the vacuum type has not evolved very far and has been found only in shelf, agitated-cylinder and rotary-drum types, and in variations on freeze-dry technique. We can look for further development here, since new types of continuous vacuum dryer are imminent. In the higher vacuum range it may be expected that regenerable desiccants will substitute in part for refrigerated condensers used in high vacuum drying, while some new ideas emphasizing short time exposure may be expected in the lower vacuum range.

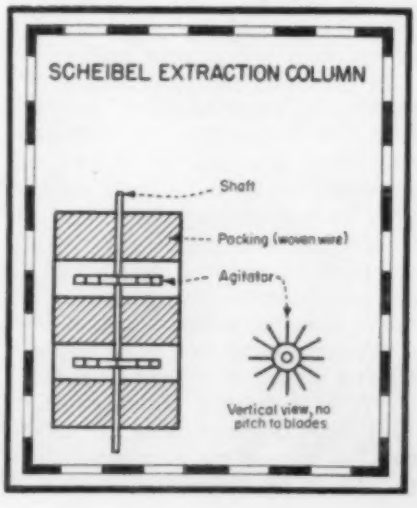
In non-vacuum drying where a carrier gas is used, variations are legion and no attempt will be made here to classify them. It will suffice to point out certain trends applying to some types, where developments of importance have been taking place.

In dryers where heat is provided by direct contact with a heated metal surface, as in drum dryers and paper machines, there is a definite tendency to use higher temperatures and shorter exposure. One manufacture, for example, is now building drum dryers for heating with Dowtherm vapor. Development of welded paper machine rolls has permitted use of higher steam pressures and temperatures, which means either a shorter dryer or higher web speed. It is being claimed that the boost to drying speed given this way more than offsets higher temperatures and permits more sensitive materials to be handled on drum dryers than formerly.

Also, drum dryers have been improved mechanically to a rather marked degree. Vacuum drum dryers of the double-drum type are now being built, following solution to the problem of drum clearance adjustment during operation. Dimensional stability of drums has been improved, to permit closer clearances, and stainless steel construction has become popular. Atmospheric drum dryers are being inclosed in some cases to improve working conditions and control dusting. Drying uniformity has been improved by automatic control of liquid depth between the drums.

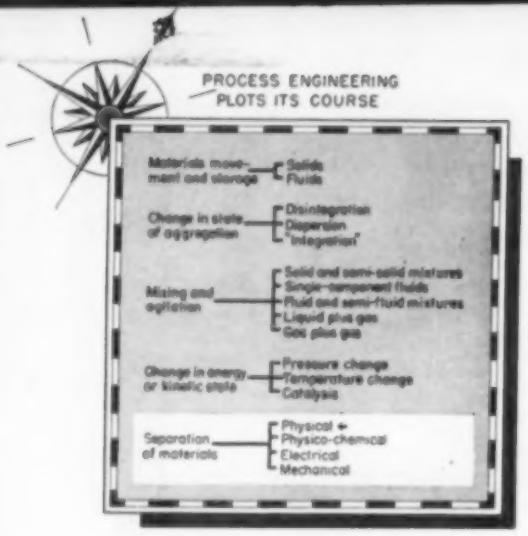
Spray Drying—Although equipment for spray drying is costly, this method has been increasing for applications where physical form of a spray dried particle are desired. Aside from mechanical improvements applying primarily to spray-producing equipment and to means of collecting and removing the dried product, there have been few recent changes. Less efficient thermally than dryers in which vapor reheating is possible, it may be that any very large increase in use will have to await development of cheaper methods of construction.

Infra-Red Drying—Although widely applied in "drying" finishes, infra-red radiation has not made as rapid progress in other sorts of drying as predicted. Part of the difficulty has been that in some earlier applications insufficient attention was paid to need for positive air movement for removing evaporated water. Part has come from the fact that infra-red radiation does not penetrate deeply and so is best suited to thin films and layers. Its energy is inherently expensive when lamps are used, but this can be overcome with gas-fired radiant heating units. Simplicity of equipment is a powerful factor in favor of this method and much future effort can be expected in determination of best methods for its use, and best types of application.



Dielectric Drying—Dielectric heating has made little progress in drying in spite of early expectations to the contrary. Both equipment and energy cost are high and advantages of producing the heat "in place" have not in most drying applications been able to out-weigh these factors. Furthermore, to avoid damage from internal pressure it is necessary that the product be porous. To avoid uneven heating, it has to be relatively uniform in both composition and thickness. The method will doubtless make further strides, but only for applications where some very special problems are met. Perhaps one of its best prospects will be in preheating of bulky materials where drying can be completed in a convection dryer. Largest applications for dielectric heat, however, are expected to remain in non-drying processes where heat transfer by conduction or convection is difficult.

Not much theoretical work has been done on drying in recent years and current equipment developments, aside from those mentioned, are not numerous. A few modifications in means for moving the material have been brought out but there have been no



really fundamental changes for some time. One of the most useful future jobs will be to standardize methods of dryer testing and reporting so that the user's selection task will be facilitated and made more reliable.

Crystallization . . . . . .

In recent years crystallization has moved very largely from open tank crystallizers equipped with a cooling coil, to the vacuum crystallizer where it can be carried out without heat transfer through conducting surfaces. One authority estimates that as high as 90 percent of new installations are vacuum cooled. Much attention is paid in modern crystallizers to control of crystal size, as well as to conditions under which crystals are grown. In some cases it is now possible largely to eliminate simultaneous precipitation of isomers and side reaction products through exact control of supersaturation of certain organic materials.

Vacuum crystallizers may be either batch or continuous in operation. The Krystal or Oslo type is inherently continuous, while the Swenson is adapted to either. A trend at present is toward increased use of continuous crystallization of organic chemicals. Compared with open-tank crystallization, the newer method produces larger, more uniform crystals which centrifuge and dry more readily and eliminate dust losses inherent in small crystal sizes. When material must be crystallized from an organic solvent, the newer method offers a further advantage of reducing fire and explosion hazards, and cutting solvent losses to negligible proportions. Vacuum crystallizers seldom have difficulty with crystal deposits and have no heat transfer problem.

Present trend toward large and controllable crystal size will continue, both in organic and inorganic fields. Since vacuum equipment may be constructed readily of corrosion resisting materials, this method will probably spread to recovery of chemicals from acid solutions. While crystal theory is at present apparently in a fairly satisfactory state (although there are divergent theories), this cannot be said for solubility data which are lacking for many important chemicals, and make a fruitful field for future investigation. Fruitful also is the problem of securing more and better information on effects of impurities, pH and other variables on results that can be achieved. Despite many successful installations on a wide variety of products, much information needed for further expansion of this unit operation is still lacking.

Adsorption . . . . . .

During and since the war adsorption has been a major factor in chemical engineering development. Wartime advance consisted in further improvement in fixed-bed adsorption units which now are completely automatic in operation. Big news has been made since the war, i.e., development by Union Oil of California of the Hypersorber.

Although the Hypersorber was initially announced in 1946, the first operating data are just coming out. First commercial Hypersorber to be installed has gone in at Dow's plant at Midland, Mich., engineered by Union Oil, Dow, and Foster Wheeler. Beginning operation just a year ago, complete details of start-up and operation for the first seven months were recently presented at the AIChE regional meeting at Cleveland. The unit recovers ethylene from the overhead stream of the demethanizer column of an existing low-temperature fractionation unit. Technical success is attested by operating results. Feed gas contains 4.5 to 6.0 percent ethylene, remainder being substantially hydrogen and methane. Ethylene product runs 92 to 93 percent ethylene, with a maximum contamination of less than 0.1 percent methane.

In principle, the Hypersorber is a continuous, countercurrent, gas-solids contactor. Separation is effected by differential adsorbability. Feed gases enter half-way up the column, meeting fresh carbon flowing down. As gas flows up, adsorbable gases are adsorbed and methane and hydrogen, which do not adsorb, continue up and are removed from the column. Carbon flows down the column to a point where it meets a stream of stripping steam rising from a heated bottom section. This strips ethylene from the carbon and the released gas is removed from the side of the column. Carbon then goes down through a Dowtherm-heated section where steam is introduced and last traces of adsorbed material are released. Conveyed to the top of the unit by a gas lift, the carbon is first cooled and then re-contacted with feed gas. Since adsorption is exothermic here, bed temperature rises markedly as the carbon moves down, a fact used to control operation of the unit by control of bed temperature just below the feed.

Gas removal is accomplished by plates in the column, having a series of downcomers. Carbon flows down through downcomers, and intervening space is then utilized for gas removal or introduction.

Control of carbon flow is also accomplished by plates. A movable plate oscillates below a fixed plate, alternately filling and discharging its downcomers at the end of each oscillation.

Although the initial commercial unit has two product streams, non-adsorbed material and adsorbed ethylene, future use of the Hypersorber may well involve a side-cut. Refluxing action that occurs above the heating section gives a concentration of middle components of a three-component feed in one section of the column. By having a plate at this point, a middle cut can be taken.

An example of the side-cut principle is recovery of ethylene from cracking gases where a low-temperature fractionation unit does not precede the Hypersorber. Feed would contain hydrogen and methane, the light materials; ethylene, the wanted middle material; and C_3's, the heaviest materials. On a pilot plant scale such separation can give a middle cut containing 91 percent ethylene with an ethylene recovery of 99.8 percent.

Possible applications of the Hypersorber are legion. Among the best appear to be purification of ammonia and methanol synthesis recycle gas to decrease purge and raise yield. Other possible applications include removal of sulphur compounds and carbon dioxide from hydrocarbon and methanol synthesis gases, recovery of acetylene from hydrocarbon oxidation gases, and separation of methane and hydrogen chloride.

The Hypersorber is new and its value is hard to measure. Its high capital cost compared with fixed bed units makes it unlikely for solvent recovery, but its greatest applications may be where it either does a job nothing else can do, or can replace low temperature fractionation. Two limitations are worth mentioning. First, the molecular weight of tail gas cannot be above the C_4 range and still get good desorption. Higher molecular

weight materials gum up the carbon. Second, allowable vapor velocities are rather low, held down by need for downward carbon flow. Hence capacity may be low unless the unit is operated under pressure. If gas to be separated is already under pressure, this problem is minimized.

It is interesting to speculate on possible application of fluidized solids technique to adsorption. British work has led to patenting of such a unit, utilizing a boiling bed. Here a gas containing 1-2 percent ethylene is passed up through the fluidized adsorbent, solids being removed at the bottom to make the unit as nearly countercurrent as possible. Adsorbent is stripped and moved to the top of the bed by conveying it pneumatically with superheated steam. After condensation of steam, the product gas desorbed from the carbon contains 45 percent ethylene.

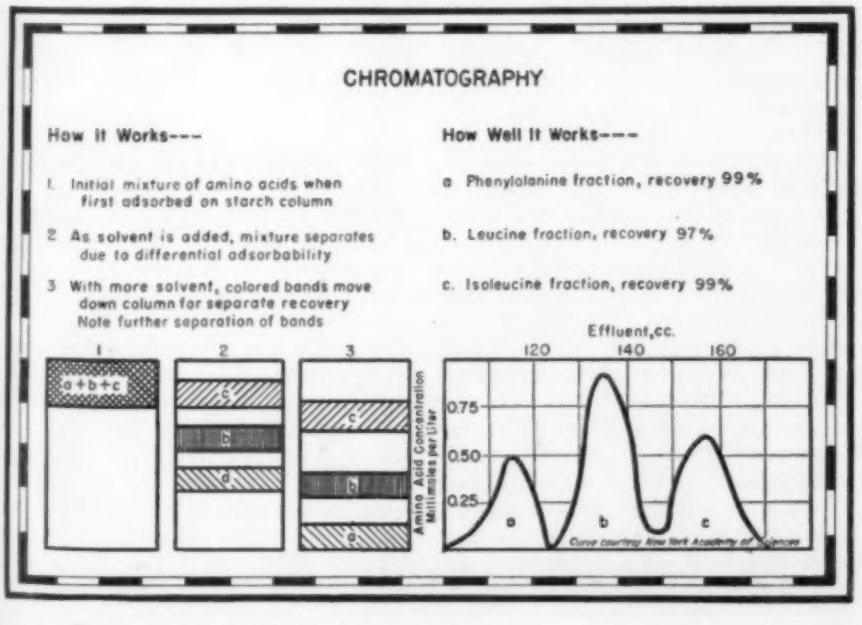
The carbon is cooled before being returned to the boiling bed. The possible advantage of such a system is that it is isothermal. On the other hand, to get a fractionation effect, this factor of isothermality is a handicap.

Traditional fixed-bed units have had further development too, some being completely automatic, available in standard sizes. Carbon units are still most used for solvent recovery. For dehumidification, activated alumina and silica gel units are widening their fields of application. The biggest new use has been in "Operation Zipper," the storage of naval vessels under rustproof conditions. There seems to be interest in possibility of using adsorbents in pre-drying air for low-temperature drying of heat-sensitive materials. A few relatively small-scale installations of this sort in the past gave inconclusive economics. Fuller evaluation of the method is needed.

Chromatography . . . . . .

Another application of adsorption that has suddenly come into the plant-scale picture has the imposing name of chromatography. Long a tool of interest in laboratories, it is now being applied in plant-scale purification of streptomycin and in producing beta-carotene from alfalfa. The method's long history started with botanist Michael Tswett, who used it for fractionating pigments in a petroleum ether solution of chlorophyll. As he filtered his solution downward through a column of adsorbent he obtained a separation into various colored zones, since the more strongly adsorbed pigments displaced the more weakly held, forcing them farther down the column. Separation became practically complete as he then passed a stream of pure solvent down the column. In 1906 he wrote, "Like rays in the spectrum, so the different components of a pigment mixture are resolved on the calcium carbonate column according to a law, and can be estimated on it qualitatively and also quantitatively. Such a preparation I term a chromatogram, and the corresponding method, chromatography."

Success of this former laboratory method in the two commercial applications mentioned presages further use of chromatography in the chemical industry. Perhaps the next major application will be in petroleum. This tool is unique in that separations of high molecular-weight, non-volatile materials can be made without use of either high temperatures, or high vacuum.



Separation by chromatography is accomplished by differences in tenacity with which different chemicals are adsorbed on a solid. By adsorbing a mixture of materials on top of an adsorbent column, the chemicals can then be separated by "eluting" with a solvent, one chemical passing down the column faster than another. Fact that this work was originally done with highly colored materials caused the "chroma" in its name, but use is not limited to colored materials. Chromatography is interesting for the sharpness of separation possible, even between materials that cannot be separated practically in any other manner. For instance, high molecular-weight amino acids that differ in structure by as little as one methyl group can be completely separated with almost 100 percent recovery, 100 percent separation, and 100 percent purity, as the chart* indicates.

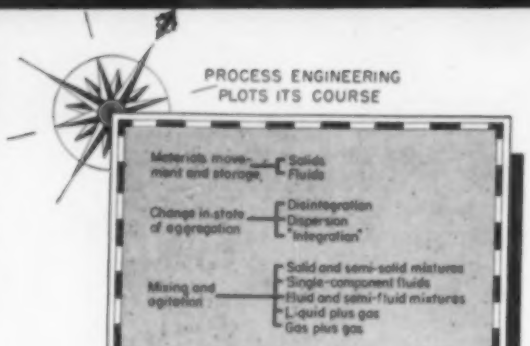
Technically, chromatography is in its infancy. Little is known about surface reactions that take place during adsorption and desorption. Efficiency with which various adsorbents will separate given compounds cannot be predicted on paper. Still, large installations can be built, based on small-scale research information. Dimensional analysis is being applied to scale-up, and looks successful.

Adsorbents used so far have been primarily such old-timers as silica gel and activated carbon. As background knowledge grows with ion exchange resins, possibility of tailor-made resins will become a reality. Synthetic ion exchange resins have already been used on some separations, notably by Manhattan District on production of pure rare earth compounds. New ion exchange resins hold out a promising future for chromatography.

Little has been told of the two commercial installations. For two years or more Valley Vitamins, Inc., subsidiary of Godfrey L. Cabot, has been producing chlorophyll, xanthophyll, and beta-carotene from alfalfa at McAllen, Tex. Here alfalfa is extracted, the extracted solid and solvent separated with a continuous centrifuge, and desired materials separated and recovered in a chromatographic column. A special form of activated carbon is used as the adsorbent. Very little decomposition of the heat-unstable plant pigments occurs.

Streptomycin, as produced, is contaminated with non-active other chemicals. But since the desired product is heat-sensitive, and unwanted im-

* Moore and Stein, "Partition Chromatography of Amino Acids on Starch," *Annals N. Y. Acad. of Sciences*, Vol. 49, Art. 2, p. 266.



purities are chemically close to streptomycin, purification of the antibiotic was a real problem. Few data are available on the plant process used, but streptomycin solutions are being purified by chromatography in the Merck plant at Elkton, Va. Small-scale work was done with alumina as adsorbent and 80 percent methanol as solvent. Concentrates having 150-300 activity units per milligram were fractionated and purified to give concentrates with 600-900 activity units per milligram.

Present basic weakness in chromatography is, first, that it is a batch process, meaning inherently high operating costs and investment. There are indications that contacting and desorption may become continuous, but actual equipment is probably a long way off. Second, adsorbents used have low capacity, and much adsorbent may be necessary to recover relatively little valuable adsorbate. Modified synthetic ion-exchange resins may change this.

Against this are favorable aspects. Chromatography can accomplish two specific objectives when other methods fail: (1) Separation of materials which cannot withstand temperature conditions or solvent action required in distillation, extraction, or even molecular distillation; and (2) separation of materials by differences in molecular structure rather than by chemical properties.

Separation by molecular structure leads toward the most promising future seen for chromatography, permitting separation of a mixed petroleum fraction into separate olefin, paraffin, and aromatic fractions. When volatility characteristics of materials are similar, or compounds are heat-sensitive, this is the only practical way. U. S. Bureau of Standards has been using this technique on a laboratory scale for several years. Hints that petroleum companies are working with it suggest the next, and largest, application. Adsorbent will probably be silica gel.

Used first in fine chemicals where profit margins are greater, nevertheless, chromatography's accomplishments are unique, and its potential appears to be important. Next and greatest uses will undoubtedly be in the basic chemicals.

Other Physical Separations . .

Freezing—As a method of separation, freezing has usually appeared on lists of unit operations but its past uses have been few—except by farmer-manufacturers of "Jersey Lightning." Now freezing seems to be coming into its own. Air purification in new tonnage oxygen processes is based primarily on freezing water vapor and carbon dioxide from the air stream. And, shades of the Jersey farmers (!), Commonwealth Engineering Co. of Dayton has announced a patented concentrating method for solutions of less than eutectic proportions in which: (1) The solution is completely frozen; (2) ice is finely divided; and (3) ice is subjected to considerable pressure, releasing the concentrate in liquid form and leaving most of the water as ice.

Its applications are said to exist both in fruit juice concentrating and in chemical manufacture. Just as an example, application of 1,000 psi. to an ice containing 5.5 percent NaCl is said to produce a 26.8 percent NaCl solution containing 85 percent of original solute in 17.5 percent of original water.

Evaporation—With one exception there have been no very marked trends in evaporation for several years past. Evaporators of usual types have been subject to mechanical improvements such as further extension of forced circulation, use of greater numbers of effects to offset rising fuel costs, use of higher liquor velocities over heating surfaces to avoid overheating of heat-sensitive materials, and improvements in application of special construction materials.

The exception lies in renewal of interest in vapor recompression evaporation, a subject thoroughly discussed and rejected in the United States about 25 years ago despite some fairly favorable experience in Europe. Cause for this rebirth of interest was successful and extensive use of the Kleinschmidt sea water evaporator during the war. As matters stand at present the most likely applications are still in preparation of distilled water for pharmaceutical and chemical applications demanding water of highest purity; or for large-scale production of fresh water from sea water or brackish supplies where solids content is too great for de-ionization.

Milk evaporation is also a possibility in small processing units where elimination of a boiler plant may be desired, or cooling water is a problem. Limiting factor for such evaporation is the available temperature head which cannot be great with low-cost, economical compressors. This limits the process to solutions with a small or negative boiling point elevation, which will give rise to little or no scale on transfer surfaces. Several sizeable water units are now operating or projected.

Molecular Diffusion—Little need be said about separation methods depending upon molecular diffusion without phase change, other than to point to their existence and present uses. Gas diffusion through a porous barrier remains our main reliance for concentration of U-235 but it has not yet been applied commercially except in isotope separation. Although at first blush it appeared to have possibilities for separation of non-isotope gases differing considerably in molecular weight, more mature evaluation seems to have produced the conclusion that this is a "last chance" operation, owing to heavy investment and extreme complexity. Liquid-liquid thermal diffusion is also a handy isotope concentrator, used initially in making a U-235 concentrate for the Oak Ridge electromagnetic plant, but since the latter is not now running uranium, only probable present use for thermal diffusion is in concentration of some of AEC's product isotopes, and in study of molecular properties of liquids and gases—as a considerable present literature would indicate.

Dialysis continues to provide viscose rayon manufacturers with a ready means of recovering steeping caustic, and biological manufacturers with a means of purifying serums. This "molecular filter" has not, however, progressed much beyond this point. Further prospects do not look very rosy.

Psysico-Chemical Separations . .

There are three separation methods which, although they might ordinarily be considered as unit processes, under certain circumstances do partake of unit operation characteristics and so are listed here. Both electrolysis and double decomposition are possible methods for separation of certain isotopes. The first has been used in heavy water concentration and the second in separating the isotopes of both carbon and nitrogen. They are not, therefore, of present interest except for research purposes. The third, ion exchange, has tremendous inter-

est to industry and is dealt with in the next section.

Ion Exchange . . . . . .

Ion exchange, long a factor in water purification, is moving rapidly into new fields. Even in water treatment, new developments are widening scope of use. Biggest new factor in the field is commercial production of strong base resins, resins which can remove weak acid ions directly. Commercial possibilities of this development are just getting started.

In general, ion exchange covers three fields. The first is removal of ionic materials from solution, together with their recovery if desired. Here the biggest application is demineralization of water, replacing older chemical or distillation methods. For modern boiler plants and users of distilled water, ion exchange does the job at lower cost. Plants can be built to handle almost any capacity and any water supply within reasonable dissolved-solids range, to deliver almost any required effluent composition. Operation can be manual or automatic, although trend is toward automatic control as a labor-saving method.

Other uses involving ion removal are for sugar refining and purification of formaldehyde. In sugar refining, juice purity can be raised from 90 percent with conventional methods to about 97 percent with ion exchange. At the same time, sugar recovery rises from about 84 percent to better than 95 percent. When these are added to lower operating costs, ion exchange's future in sugar refining appears assured. Formaldehyde made from methanol by oxidation over silver catalyst contains a small amount of formic acid. Presence of formic acid is undesirable in manufacture of phenolic and other resins using formaldehyde. Ion exchange is now being used extensively for formic acid removal.

Among new uses is recovery of metals from dilute solutions, particularly from plating operation wastes. This type of operation not only removes a waste disposal problem but can also recover valuable metals for recycle and yield improvement. Other waste disposal problems are being approached with ion exchange.

The second field for ion exchange is in conversion of salts, or metathesis. Here the field of application is wide, but use of ion exchange resins is just beginning. Commercial applications that serve as examples include conversion of streptomycin sulphate to streptomycin chloride, and production of colloidal silica ("Ludox" process) during which sodium silicate is converted to silicic acid by ion exchange.

The third field ion exchange can cover is fractionation, i.e., separation of mixtures of materials. Today this is the one untapped phase of ion exchange. Only published information is that given by Manhattan District on separation of rare earth elements by this technique. Called "complexing elution," the technique used comes close to chromatographic separation. It differs by the fact that chemicals are temporarily bonded to the resin by chemical (ionic) means, rather than directly by adsorption. In time this may be the field for ion exchange with greatest over-all prospects.

Ion exchange today has many shortcomings, most prominent being lack of technical knowledge. Design, scale-up factors and uses are all determined on an empirical basis. Technology of reactions has not been worked out satisfactorily although much work is being done. Any deviation from well-trodden paths means a major research and development program. Much more fundamental study is necessary.

Another weakness is requirement for batch operation. This means that more complete ion removal possible by a truly countercurrent system cannot be obtained. It also means that labor and capital costs are necessarily high. All ion exchanger manufacturers are working hard on this problem. One development-sized column was in operation for some time but has now been shut down. It apparently was not the answer. Perhaps TCC technique for moving solids countercurrent to a stream of fluid will be the general method used, although it is possible that fluidized systems (liquid-solid rather than gas-solid) will play their part.

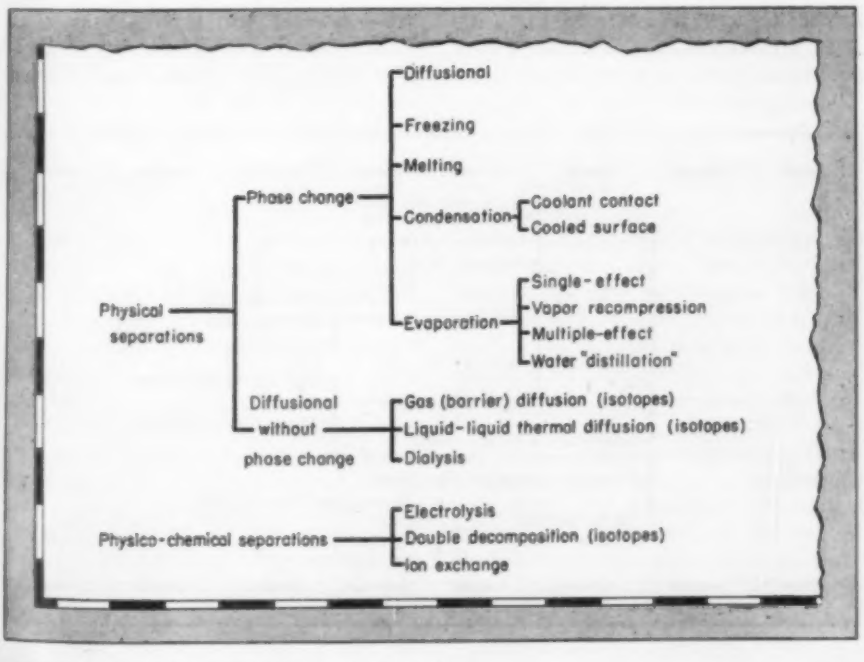
From the standpoint of resins themselves, present weaknesses point the way to future developments. There appear to be three directions in which resin research is being concentrated.

First, efforts are being made to increase activity or ion capacity of the resins. This means putting more and more active groups into an already highly active molecule. The limit is set by required insolubility of the entire resin. High capacity of newer resins, introduced in the past few years, indicates that perhaps the limit is being reached.

Second direction of research work is aimed at increasing spectrum of activity of the resins. Newest development in this field, mentioned above, is production of strong cation resins. First use of such resins has been removal of silica from boiler feedwater without addition of sodium fluoride or other introduction of fluoride ions. Resins employed are secret in composition but are based on presence of quaternary amino groups in the polymer chain.

In increasing the spectrum of activity there not only is a desire to have strong and weak acid and base resins, but also to improve selectivity of ions removed. With increasing selectivity, use of ion exchange as a method of separation of chemical mixtures should grow rapidly.

Third direction of ion exchange resin research deals with modification of physical properties of the resins, specific gravity, porosity, particle size, etc. These may all have a direct bearing on activity and separation ability.



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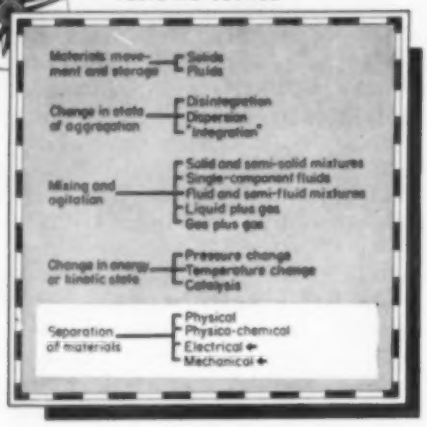


Electrical Separations

ELECTRICAL METHODS for separation of materials were, until development of U-235 concentration processes, practically limited to: (1) Separations based on magnetic susceptibility; and (2) separations dependent on ability of materials to take an electrostatic charge. During development of Manhattan project, however, several methods using magnetic forces to distinguish between gaseous ions on the basis of mass were developed. Of these, only the Calutron (electromagnetic separator) was fully developed, and because of general complexity and low output of these methods, it is doubtful if any will be applied other than for isotope separation, and for analysis as in the mass spectrometer.

Two other methods also used in isotope separation depend on action of ions, but in these the ions are in solution. In the better known case the residue from the continued electrolysis of water becomes enriched in deuterium, whereas the hydrogen released by the process contains from one-third to one-sixth of normal concentration. This method either alone or in combination with distillation has been used extensively in producing heavy water. The second, lesser known method makes use of slower movement of heavy ions when an electrolyte flows through a packing in a direction counter to the ion flow under influence of an electric current. Called countercurrent electromigration, this method concentrates heavier ions at the end toward which liquid flow is moving.

Magnetic Separation . . . .

Magnetic separation seems to be verging toward increased use as efforts are directed toward beneficiation of our poorer mineral raw materials. No new principles have been introduced recently, but one trend has been strikingly apparent, namely, development of a great number of permanent magnetic separators for removal of ferrous contamination. Although permanent magnets have been used for many years, introduction of the Alnico magnet was responsible for a marked revival of interest. Such equipment is now made not only in spout and pipeline types but also in drum and in pulley-and-belt type separators. Conventional electromagnetic types continue much as in earlier years. High intensity types seem to have come close to a performance peak owing to mechanical problems and hysteresis losses. Cross-belt type separators are being built for more simultaneous cuts and appear to have been stepped up somewhat in selectivity and intensity. Separators of the magnetized grid type, formerly used primarily for removing magnetic contamination from slips and suspensions, have moved into the powder field, with mechanical vibration now available if needed to assure flow.

Electrostatic Separation . . . .

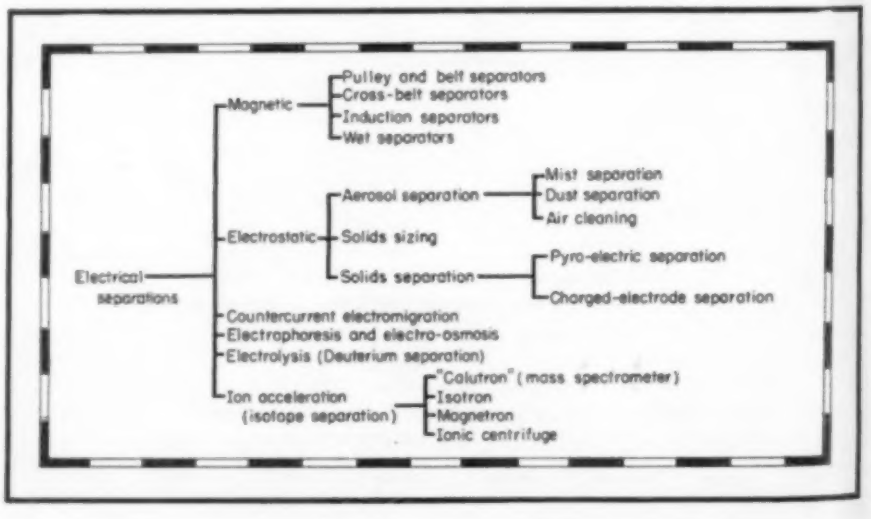
Electrostatic separation has been used extensively in the separation of aerosols from gas streams, and less extensively for separating solid particles of different electrostatic conductance. There has been a small application in the sizing of particles of a single species.

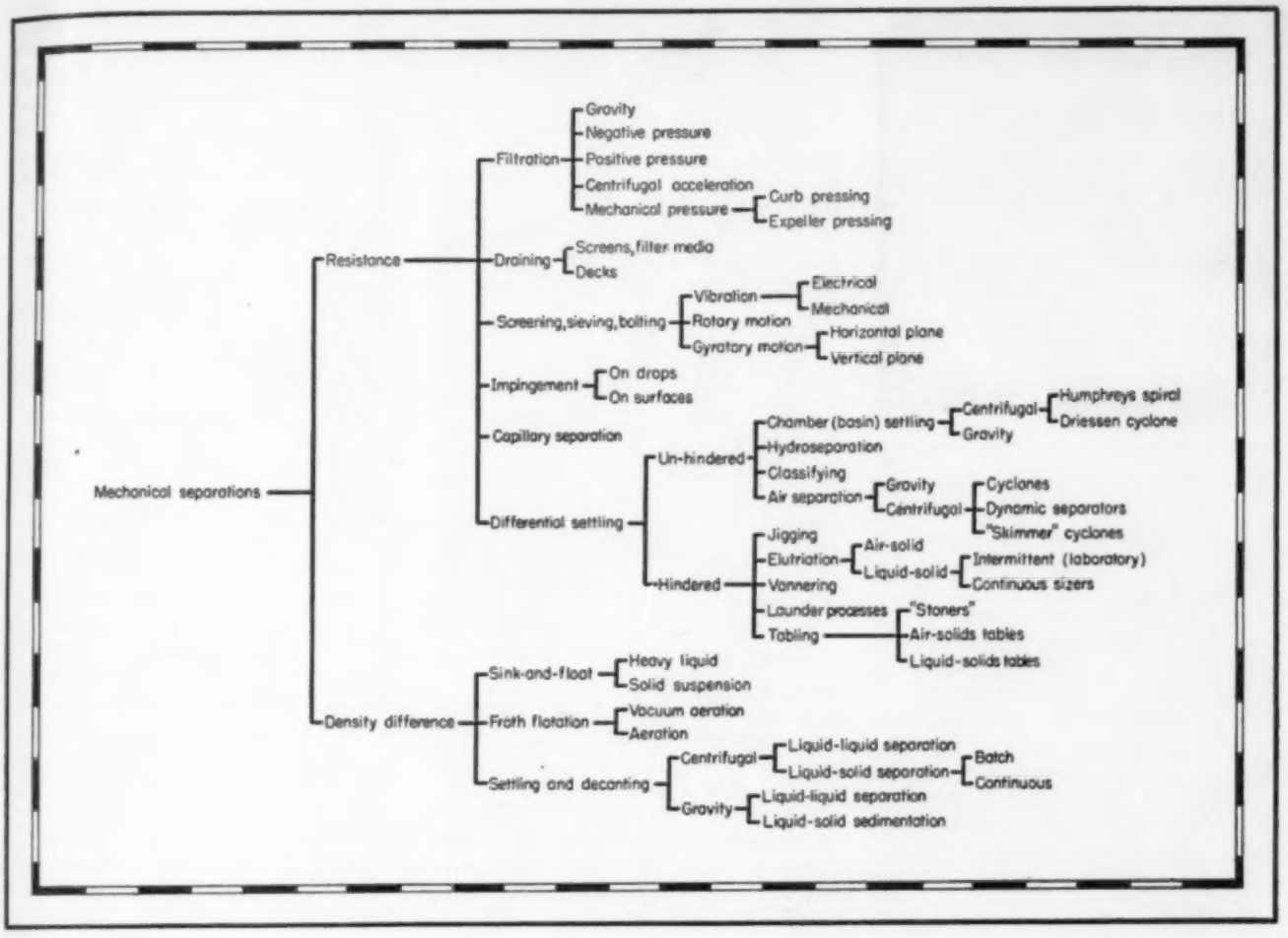
Aerosol Separation—Principle developments in recent years in this field have been improvement and simplification of electrical equipment, and adaptation to a wider range of applications. For example, there has been considerable increase in use of electrostatic precipitators in air cleaning, where lower voltages must be employed to avoid formation of nitrogen oxides. Until recently the precipitator has had little competition in the collection of finest industrial dusts and mists. Possible competitors now include ultrasonic agglomerators and special designs of wet cyclone.

Solids Separation—Last five years has witnessed considerable advance in electrostatic solids separation, although the theoretical side is still in a chaotic state. For example, although it has been considered that materials must be very dry for satisfactory work, it is now found that separation works on some moist materials. The method is useful only in a size range from about 8 to about 150 mesh which sometimes limits its use, but it is going increasingly into work on phosphate rock, titanium minerals, abrasives and other non-metallics. Now most practical method known for separating rutile and ilmenite, it is becoming of interest in recovery of zircon, monazite, garnet and kyanite.

Separators themselves have been improved so that tonnages as high as 400 lb. per rotor inch per hour can be separated, compared with 60 lb. a few years ago. Improvement has taken place in electrical equipment, insulation, and the associated air conditioning to control surface conditions of the material. In some cases surface treatment of particles may be effective in improving separations.

Electrophoresis—Some evidence suggests increase in interest in processes similar to electrophoresis (electro-osmosis), for such purposes as beneficiation and dewatering of clays and kaolin. The process has had some





application in Europe, is basically dependent on the fact that electric charges are accepted differently by various kinds of mineral particles suspended in a weak alkaline electrolyte. Direct current passed through a suspension causes clay particles to migrate to a rotating anode, while other particles drop out or pass to the cathode.

Mechanical Separations

SEPARATIONS that are here classified as mechanical include solids from liquids or gases, solids from other solids, liquids from other immiscible liquids, and liquids from gases. Methods involved depend upon such properties as particle size, particle inertia and specific gravity differences. In case of froth flotation still another property, namely, ability to assume a false specific gravity by preferential attachment of air bubbles, is employed.

Except for separations listed near the bottom of the chart, where solids are separated from liquids or other solids (or liquids from liquids) entirely by specific gravity difference, all methods included here depend on use of some kind of resistance to bring about separation. For example, in filtration, solids are separated from liquids or gases by resistance of a filter medium. In impingement, particles are removed from a gas stream by impingement on and adherence to surface, droplets or froth bubbles.

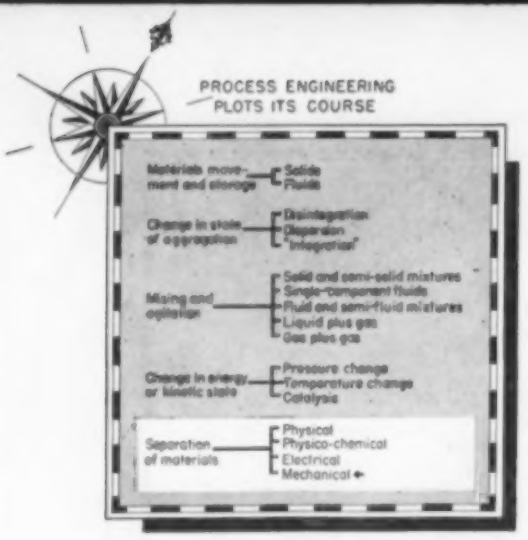
However, in differential settling, the resistance may be that of a fluid through which a mixture of particles is falling. Since falling speed of a particle in a fluid depends on both size and specific gravity, it is possible to separate a homogeneous material by particle size, or a mixture of sized materials by specific gravity. Some methods permit quiescent settling, or accelerate it centrifugally; in others settling may be hindered by certain kinds of agitation or by rising currents, in order to give a longer time of fall and thus improve separation where density or size differences are not great.

Since particle size is important in many separations, it is significant that improved methods for particle size determination, particularly in the subsieve range, are of much interest at present and have resulted in recent comprehensive symposiums both here and in England. At many points work is continuing on such methods since, despite recent progress, measurement problems have by no means been solved.

Not all discussion below will follow strict logic, since in some cases practical equipment combines two or more principles shown in the chart. Also, it is better to discuss centrifugals at one time, rather than to insist that some are centrifugal filters, others settlers, and still others, differential settlers.

Filtration . . . . . .

Gas-Solid—Although dust filters have been improved mechanically in the recent past—largely for increased ease in replacing filter media, there has been only one striking variation in principle. The new Micro Collector utilizes a cylindrical filter surface of



dense felt, cleaned continuously by an automatic "back-blow" ring traveling over its surface. It is thus possible to make use of a denser medium and still secure air flow rates as high as 30 cfm. per sq. ft. Other news of importance is concerned with dust filter media which are now undergoing development for higher temperatures and more corrosive conditions. Natural fibers largely used in the past have tended to lose strength at higher temperatures, also being hygroscopic at high humidity and lower temperatures, giving cake trouble. Higher temperature cloths prevent condensation and avoid corrosion troubles likewise. In addition to glass fabric, newer synthetics about to come on the market will handle temperatures to 275 deg. F., others to 450. Various degrees of corrosion resistance will be available and present work suggests that cloths for still more severe temperature and corrosive conditions will be brought out not very far into the future.

Liquid-Solid—News being made in the liquid filtration field continues to be in continuous filtration, particularly various kinds of continuous vacuum filters. Introduction of synthetic fiber filter media is widening scope of materials that can be handled by filtration.

The Bird-Young filter, recently announced, is a cylindrical vacuum machine differing from the Oliver in method of valving and application of vacuum and pressure. The vacuum cylinder is not compartmented on its outer surface. Filtrate collects as a pool in the cylinder and flows out through trunnions. By putting compartments inside which are stationary, wash waters can be collected separately. Cake removal is accomplished by blow-off.

Another new filter, the Oliver rotary horizontal filter, is an adaptation of the old sandtable. It is claimed to be particularly adapted to the dewatering and washing of granular or crystalline materials. Operation is completely visible, separation of filtrates is sharp, countercurrent washing is incorporated, and it has a novel cake discharge system.

Continuous precoat filters are moving into new fields, among them pharmaceuticals such as streptomycin and penicillin. Breaking emulsions in recovery of slop oils is another application.

Filter media have advanced considerably due to the use of synthetic fibers in their construction. Lightweight, high-twist nylon filter cloths have for the first time allowed filtering of some organic dyestuffs and pigments which otherwise could not be filtered. Here Bird-Young filter's thin cake has been of value. Yarn counts of such cloths are as high as 140x205. The result is that cloth blinding is practically eliminated and blowback cake discharge occurs freely and is extremely complete.

Other filter media which are showing increased use include glass, Vinyon, Vinyon-N, saran, and rayon cloths. Du Pont's polyacrylonitrile, Fiber A, will be another. Good corrosion and abrasion resistance mean long operating life which may often outweigh higher cost inherent in these cloths.

Another development has been nonwoven cotton and rayon fabrics with considerable wet strength. For clarification applications they are nearly lint free and sell for a fraction of the price of regular filter cloth.

Centrifugal Separation . . . .

All well known types of centrifugals at present in use have been available for several years, with little change other than mechanical improvements. There have, however, been developments in methods of operation, as well as in types of use. Trends include increased use of corrosion-resisting metals and alloys; a tendency to make centrifugal operation automatic and continuous; increased application of "packaged" separating equipment where one maker provides a complete unit of centrifugal and all auxiliaries; and a trend toward use of continuous centrifugals rather than other separating devices, particularly where former equipment was a heavy consumer of space or labor. Among centrifugals, there may be some trend away from the suspended basket, and toward both horizontal bulk and continuous machines. All types, however, appear to have peculiar advantages.

An interesting new application for centrifugals is in complete elimination of tables used for gluten separation in cornstarch manufacture. Although this method has been on trial for 15 years, it is only recently that first completely equipped starch plants have gone into operation, employing the nozzle-discharge Merco centrifugal, a continuous concentrator. A three-stage separation is used, yielding pure starch, and good gluten. Product quality is equal to or better than with tables, while labor requirements are much less, space for separation almost negligible.

An interesting advance in the Western States suspended sugar centrifugal is the employment of a constant-torque fluid coupling which permits accurate selection of desired time-speed characteristics of the cycle. Machines are individually driven (in distinction to the geared group drive formerly used by this concern), but can be group controlled as to cycle and uniformity of acceleration. This machine is being considered also for a number of uses other than sugar. Speeds of suspended centrifugals have been increasing, some 40-in. machines now being up to 2,200 rpm.

Limitations of various types of centrifugals are becoming better understood, but their application is still largely empirical. For example, in some cases higher centrifugal force is deleterious, although this can only be determined by experiment. Again, it is not always possible to predict whether any centrifugal—or which type of centrifugal—will be superior to some other separation method. It is true however, that their field of application appears to be expanding rapidly and that the body of application data now being built up is an excellent substitute for a more theoretical approach which may never be fully possible in view of the difficulties.

Screening . . . . . .

Screen separation has undergone little recent change. There appears to be a trend toward mechanically vibrated screens, at the expense of those vibrated electrically. It is also evident that more attention is being paid to screen adjustability, so that amplitude, frequency and angle can all be matched to needs in a particular case. An application of screens that is of increasing importance is in dewatering operations, instead of filters. One recent example is elimination of filter pressing of finished slip in several plants in the ceramic industry. Here a 2 x 5 ft., 80-mesh screen handles 1,500 gph., taking slip directly from the raw

blunger and eliminating both filtering and an extra blunging.

Impingement Separation . . .

Dust collection equipment for the finer particle sizes is becoming of increased importance as regulations governing atmospheric discharge of such materials become more stringent. Many of these devices employ impingement of particles on water drops or wetted surfaces as a means of trapping them and preventing their loss. Then centrifugal force or other inertial effects are generally brought into play to eliminate the water from the air stream. Water elimination itself may also be a case of impingement on surfaces placed in the air path. Another variation of this idea forces the dust laden air through a foam blanket where stabilized bubbles act as traps for particles.

There have been few new types of such equipment in recent years, although some equipment has been further evaluated and put to new uses. The Pease-Anthony type of sprayed cyclone, for example, has met with success in recovery of salt cake fume in the paper industry and in a number of other applications involving extremely fine particles. New development here is use of a venturi ahead of the cyclone, with wash liquor injected into the venturi throat. With this arrangement it has been found possible to operate the cyclone dry and still obtain high collection efficiency (90 percent on salt cake fume). If necessary, efficiencies in the order of 95-99 percent are claimed to be possible when the scrubber is sprayed in the usual manner, following the sprayed venturi.

Capillary Separation . . . .

Developed a few years ago, there has been further improvement and increased application of a novel immiscible fluid separator for breaking rough emulsions and gas-liquid separation, which depends for its effect on use of treated porous diaphragms. In a water-oil mixture, for example, it is possible to employ two porous ceramic filters, one given a hydrophilic treatment to pass water, the other a hydrophobic treatment to pass oil. The mechanism of this Selas development may be explained by pointing out that if an oil-water interface exists across the entrance of a capillary which is wet with water, then below a certain critical pressure the interface will hold and oil cannot pass. Same situation occurs at a capillary that is wet by oil, except that here water will be held back by the interface, unless it is ruptured by sufficient pressure. On the other hand, until an interface intrudes, water flows readily from a water-wetted capillary and oil from one wet preferentially by oil. Centrifugal action also is used in practical equipment in some cases to effect an initial separation and prevent permanent blocking of capillaries. The same general method can be used to separate water continuously from air, as for instrument air lines.

Differential Settling . . . . .

Wet Separators—Minor improvements of a mechanical nature appear to have been the rule recently with classifiers and hydroseparators. A new method of classifier rake operation, which is expected to be a major improvement, in undergoing final development by one manufacturer. Larger hydroseparators have been built recently, provided with automatic rake lift to overcome strains from overloading. These have had raking capacities reported to be as high as 1,000 tons per hour.

Also falling generally within the field of wet separators are two new devices for mineral concentration in which there is a great deal of present interest. The Humphreys spiral, in active use since 1943, has been used in concentrating chromite and titanium minerals from sands, and is now going into iron ore concentration. Mining engineers anticipate a wide range of usefulness for it in handling nonmetallic minerals susceptible to gravity concentration. It is interesting to note in this connection that a trend is evident to return to gravity concentration methods where these are applicable. The Humphreys spiral differs markedly from other gravity methods, and yet uses one of the oldest concentrating principles found in nature. Its action is similar to that of a stream going around a bend and like a stream has the unexpected effect, owing to a combination of gravitational, centrifugal and frictional effects, of concentrating heavier components on *inside* of the bends.

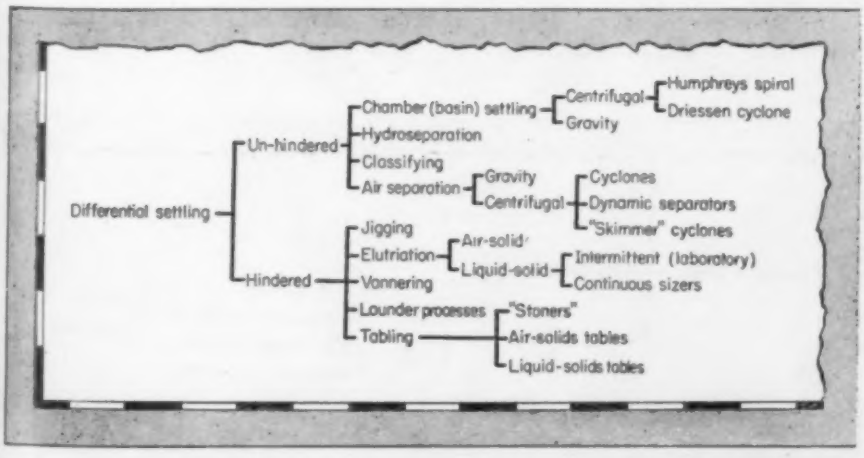
Another new device utilizing a very old principle is the Driessen (or Dutch States Mines) cyclone which, although small, closely resembles an ordinary large-diameter cyclone for dust collection. Experimentally it has been making separations as fine as 200 mesh at high capacity. Its thickening capacity is said to be enormous although it cannot produce a clear overflow and so should be considered as a classifier. At present its largest possibilities seem to be in separation by the sink-and-float process, using a medium such as magnetite.

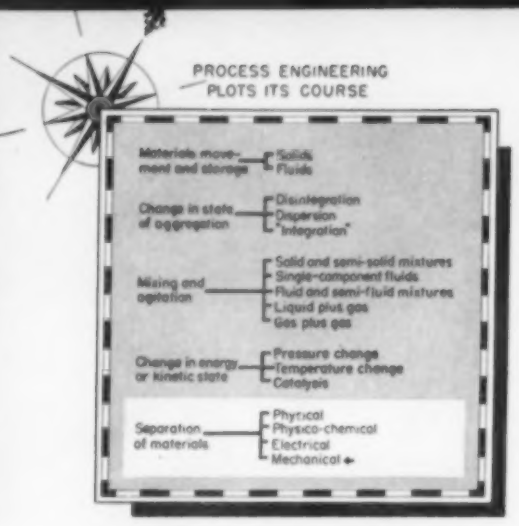
Air Separation—Air separators operating on the centrifugal principle are used to a very large extent but there has been little recent development. For collection of fine particles, one school of thought is advocating cyclone tubes as small as 3 in. in diameter, whereas another believes that diameter decrease below 6 in. is unnecessary. It is interesting to note that current experimental work on coal-fired gas turbines for locomotive use is employing small diameter cyclones for protecting the turbines from fly ash.

Incidentally, one chemical manufacturing concern that designs its own cyclones has come up with the conclusion that proper proportioning and choice of inlet velocity permits almost as high efficiency with large as with small diameter cyclones.

Hindered Settling . . . . . .

Jigs, launders and wet tables, all of which are used to some extent in nonmetallic mineral concentration, have shown some improvements, largely





mechanical. Considerable interest exists in a new jig which uses a short stroke and an extremely high frequency. There has been some recent tendency to swing back from flotation to jigging but, on the other hand, sink-and-float separation has been taking the place of coarse jigging. In tabling, there has been a swing away from use of slime tables, but sand tables are being used extensively. Agglomerative tabling is reported to have shown up well, but to be in use only by one concern.

Air Tables—Air tables, which perhaps should be classed under "hindered rising" rather than settling, have recently been going into a large number of new applications such as separation of dust from granules in plastics grinding, expanded from unexpanded vermiculite, bark from sawdust for wood flour manufacture, and spent from good TCC catalyst. They have also been used in bone char recovery in sugar refineries, and in removing cellulose from ground scrap tires without caustic treatment. A recently developed simplified version of the air table, the so-called stoner, can be used for a two-way high-tonnage separation when there is considerable specific gravity difference and the quantity of heavy material is small compared with the light.

Elutriators—Upward current devices for size separation have taken a new lease on life with improvement of the Fahrenwalt sizer enbodied in the recently developed Dorrco sizer, a multiple-compartment machine now used in classification of iron ore concentrates, and classification and recovery of abrasives.

Density Differences . . . . .

Sink-and-Float — Heavy-medium separation processes, otherwise known as sink-and-float, are no newcomer to coal, metallurgical and process industries. Biggest use has been, and is, in cleaning coal. But slowly sink-and-float is moving out into the mineral dressing field. Among metallic ores being handled are iron, zinc, magnesite, tin, and lead-zinc. In non-metallic fields, applications include garnet, fluorspar, and diamond ground.

Newest developments in heavy-medium separation equipment involve smaller units and variations in design of separation chambers. Ground ferrous materials such as magnetite are still the primary suspension medium. Heavy liquids have not panned out from a cost angle.

In order to handle larger sizes of heavy materials, Link-Belt has introduced a settling chamber that does not remove the heavy material from the bottom, as in the conventional cone. Here a bucket-type elevator is built into the chamber and elevates the heavy solids mechanically. The Akins classifier is also being used as a separation chamber.

For applications involving small quantities of solids, 15-25 tons per hr., Western-Knapp Engineering Co. has developed a semi-portable unit using ferrosilicon as the heavy medium. Value of this unit will be for plants mining small quantities of material, and for semi-works use.

Primarily, sink-and-float has good separation ability at low cost. It is the low cost angle that will lead to future applications.

Flotation—Long important in mineral dressing, flotation is becoming increasingly important as poorer raw materials must be tapped. One of the best examples is depletion of high-grade limestone deposits near several cement plants which therefore have adopted the Breerwood flotation process to control the quality of their limestone.

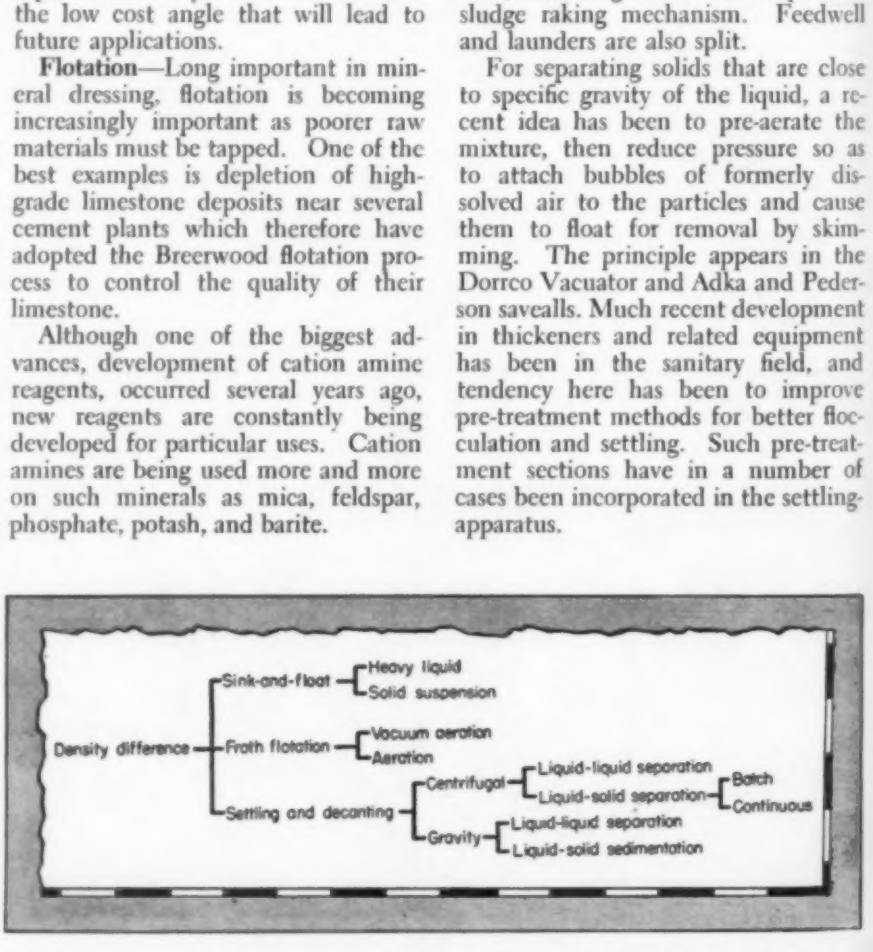
Although one of the biggest advances, development of cation amine reagents, occurred several years ago, new reagents are constantly being developed for particular uses. Cation amines are being used more and more on such minerals as mica, feldspar, phosphate, potash, and barite.

Flotation is not only being used for straight benefication, it is also being used to control quality and give several grades of product. Perhaps one of the best examples of this is in glass sand, where there are grades required for optical, flint, and container glasses that have different iron specifications.

One of the biggest new flotation plants to be installed is at the Noralyn mine of International Minerals & Chemicals. Some 1.5 million tons per year of phosphate will be produced by aid of flotation. This installation is perhaps the most highly instrumented of any to date and it involves a new double flotation cycle for cleaner separation.

Settling and Decanting—Nothing new has been uncovered in separation of liquids by settling and decanting, with the exception of use of a packed settling section in the Scheibel countercurrent contact tower discussed in connection with liquid-liquid extraction. In separation of solids from liquids by settlement (thickening), there have been a number of modifications of earlier types introduced in recent years. For example, Dorr's Duo-Clarifier achieves two clarifier stages in a single tank by use of a partition across a centerline of the tank, extending down to the top of the sludge raking mechanism. Feedwell and launders are also split.

For separating solids that are close to specific gravity of the liquid, a recent idea has been to pre-aerate the mixture, then reduce pressure so as to attach bubbles of formerly dissolved air to the particles and cause them to float for removal by skimming. The principle appears in the Dorrco Vacuator and Adka and Pederson savealls. Much recent development in thickeners and related equipment has been in the sanitary field, and tendency here has been to improve pre-treatment methods for better flocculation and settling. Such pre-treatment sections have in a number of cases been incorporated in the settling-apparatus.



Unit Operations Auxiliaries

PROCESS ENGINEERING makes use of many methods and techniques that cannot rightly be called unit operations. Because several of these are grouped here under "auxiliaries" does not mean, however, that they are subsidiary to unit operations. Some, in fact, are really combinations of unit operations.

This section, then, will touch a few high spots not strictly in unit operations groups, and will deal with fluidizing, ultrasonics, process and quality control, air conditioning, and power production and use.

Fluidizing . . . . . .

Fluidizing, heralded just a few years ago as a technique which would go into many fields of application, has moved at a snail's pace outside catalytic cracking. Slowly but surely, however, it is picking up speed. Next application for commercial use is lime calcination. One that is definitely on the way is fluid catalysis in production of synthetic fuels from natural gas.

From a technical standpoint, fluidization is still in its infancy. Little is known of fundamental properties, effect of various particle sizes, distribution of particle sizes, density of solid phase. Plenty of work is being done in research laboratories, but published results so far are not comprehensive, nor are they always without contradiction.

Some research findings have been of use in practical applications. For instance, by some unexplained phenomenon, fine solids particles tend to carry over less than larger sizes. This fact has been applied in construction of latest type fluid catalytic cracking units to save both equipment cost and reduce catalyst losses. Another unexplained fact: very small particles are hard or impossible to fluidize.

With regard to particle size, it is also known that best fluidization results with a definite spread of particle sizes, but when extent of spread is held to about four to six standard screen sizes. Within wide limits this does not depend on specific gravity of solid material nor what part of the screen range is being considered. Maximum particle size for good fluidization is probably about 4 mesh.

However, even with little fundamental data available, scale-up from laboratory equipment to full size units is not too much of a problem. Still, all proposed uses have to be tested experimentally, since some that look best on paper just don't fluidize well.

Biggest advantage of fluidization is its ability to control over-all bed temperatures within very narrow limits, even though the reaction taking place is strongly exothermic or endothermic.

As a secondary advantage, fluidization improves ability to add or remove heat from the system. It does this in two ways. First, heat capacity of solid is so high relative to gas that solids can be removed, heated or cooled, and returned to the bed to handle required heat transfer. Second, presence of solid particles improves heat transfer from gas through a metallic wall. For example, converters for synthetic fuel manufacture are being designed for a heat transfer coefficient of 150 Btu. per hr., sq. ft. and deg. F. This coefficient is far greater than could be expected from a gas stream through a solid wall without solids present.

Fluidization also gives good contact between solid and gas phases, due to tremendous area presented by the solid. There is some possibility that "slugging" and bubbling cut down efficiency somewhat, but it still appears better than in fixed bed systems.

On the negative side, there are certain solids that cannot be fluidized. In some cases this is due to excessive attrition or agglomeration. In others, such as fluidization and calcining of limestone, some samples fluidize and others, apparently similar, will not. This again points out lack of fundamental knowledge and the requirement to proceed experimentally.

True countercurrent contact between gas and solid cannot be obtained by fluidization, since there is complete solid mixing within the bed. This causes the advantage of temperature control while giving the disadvantage of non-countercurrent operation, a disadvantage partially being counteracted by installation of plates in reactors, or by multistage contacting.

For boiling-bed type units there is another limitation. Gas-solid contact times must be long enough to give a reasonable bed depth for adequate fluidization.

Many applications of fluidization have been proposed, but relatively few are in operation commercially. In current large scale operation are fluid catalytic cracking, and phthalic anhydride manufacture. In the design stage, after successful pilot plant operation, are lime calcination and liquid fuels synthesis. The Dorr Co. is ready to pilot plant a fluo-solids reactor for calcining lime sludge. Celanese is reported to be testing the use of fluidized reactors in oxidation of hydrocarbons. Another large-scale application being aggressively tackled is distillation of oil shale.

Biggest potential application is in gasification of coal for liquid fuels synthesis. Here temperature control and large introduction of heat are prime requirements. The fluidized system has just these particular advantages. From a long-range point of view this looks like the most promising future field for application of fluidized solids.

Ultrasonics . . . . . .

Use of high intensity sound at frequencies above limits of human hearing, ultrasonics, is just beginning in an industrial way. First use, and one of the most promising at long range, is in agglomerating aerosols. First plant to go into actual operation is at Pampa, Tex., recovering carbon black from exhaust gases for Godfrey L. Cabot. More units are going in and a better appraisal of ultrasonics will be possible when they are in operation.

Little is known about ultrasonics from a technical standpoint. In general it is known what kinds of things these high frequency waves can do. But applications are largely empirical, based on experiment. Even scale-up is still empirical.

There are three kinds of apparatus which will produce ultrasonic waves, two of them limited so far to laboratory scale. These last include oscillation of a quartz crystal induced by high frequency alternating current, and oscillation of a diaphragm due to magnetic size change in a bar of metal attached to the diaphragm. Both of these are small-scale devices.

Form of ultrasonic generator finding commercial application today is a high-speed siren. Standard units can operate at from 1,000 to 200,000 cycles, with an intensity of 100 to 170 decibels. Unlike the other two methods, it is not limited to very low power outputs.

Applications in operation or under construction include agglomeration of carbon black, soda, sulphuric acid mist, fly ash, and fog. Other applica-

tions being actively scouted include matting of paper mill slush pulp, and drying of powdered soap. Homogenizing of milk has been practiced commercially. Shattering ores and high-vacuum pumping have been talked about.

Future of ultrasonics is uncertain, but it will have practical applications. Carbon black recovery is a good example. What other economic and practical applications will be, it is too early to tell.

Process Control . . . . . .

Two major trends in process control appear to be, first, use of electronic means of measuring process variables, and second, increased application of statistical methods to analyze results of these measurements, and determine inspection and analysis procedures.

Electronically, perhaps the biggest new thing has been the wide acceptance of the mass spectrometer and similar instruments for control, as well as research, measurements. Petroleum companies have been the leaders in using these means of determining gas composition. High accuracy and rapidity of analysis are primary reasons. Accuracy equals, and in some cases surpasses, other means. Primary economic advantage, however, is the labor saving that is possible. Only in this way can instruments of such high cost be justified.

To be truly effective for plant operating control, such instruments must be somewhat modified. First, they must incorporate only those features necessary for the job at hand. Second, they must be able to operate under plant conditions of temperature, humidity, line voltage variations, etc. Third, they must be automatic in operation. Fourth, they must be easy to maintain. And fifth, they must provide data with a minimum of computation. Such instruments are being developed.

The electronic trend is obvious in other types of instruments than spectrometers. For temperature control and other instrumentation, electronic means have been widely used to convert primary data, such as thermocouple electric currents, into direct reading results. This trend is so pronounced that even direct thermometers are being supplanted in some cases.

Lower limit for radiation sensitive elements is slowly being pushed down. Hence, this type of measuring instrument is finding more and more application.

Rotameters continue to expand their field. Special designs give greater coverage. Rotameters are now being used for continuous viscosity measurement as well as for flow rates.

An interesting development has been increased use of hygroscopic salt coatings for humidity measurement. Variation in conductivity of these salts with moisture content is the measure of humidity. Equilibrium with surrounding atmosphere is reached so rapidly that instrument response is almost immediate.

Use of statistical analysis has grown rapidly. Its biggest application in continuous processing has been in determining the magnitude of effect of process variables, hence determining amount of control needed with each variable. In batch processing, statistics is used to determine required analyses to keep rejections at a reasonable minimum, with a minimum number of analyses. In research work, statistics is being used to determine reasonable limits of accuracy of analytical tests, hence leading to a more valuable set of specifications for products when they go into commercial use.

Power Aspects . . . . . .

Gas Turbines—Gas turbines still remain the most exciting phase of power—outside of atomic power which itself will very likely make use of gas turbines. There are still no commercial gas turbine installations in the U. S. except 30 or so in Houdry process plants, but they are coming rapidly. About 47 gas turbines are being built today throughout the world, ranging up to 27,000 kw. in size. Within ten years gas turbines will probably be a major source of power. In process field their ability to combine steam raising, air compressing and power generation makes them especially favorable; ability to operate on waste gases from both combustion and reactions makes them interesting from a process standpoint. Quite probably some gas and vapor phase processes now operated at lower pressure will be conducted at higher pressure in future to permit incorporating gas turbines into the flowsheet.

Present gas turbine trends suggest that current recognized temperature of 1,100-1,150 deg. F. can shortly be raised to 1,300-1,350 deg. F., since experimental machines are operating satisfactorily today at that level. Much discussed 1,500-deg. machines seem still far in the future. Blade cooling is largely out so that higher temperatures will depend on better materials. Many gas turbine cycles have been developed, but highest efficiency cycles, involving most complexity, will probably be economic only in large stationary installations.

Steam—In boilers there is little new except the cyclone furnace mentioned in an earlier section. Trend is slightly downward as regards pressure, and slightly upward on temperature. A pressure of 900 psig. and a temperature of 900-950 deg. F. is now regarded as a good stopping point. There may be some possibility of fluidized combustion for steam raising. It is worth watching. Although there is no present interest in supercharged boilers in the U. S., gas turbines may change this. As for steam turbines, a move is now afoot to effect some standardization in industrial sizes. Although there may be some trend away from turbine drive for machinery, and toward motor drive, geared turbines with integral gearing are becoming more popular. Turbine size is growing, and over-all efficiency is increasing slightly, although it has nearly reached a plateau.

Motors—Motors do not change much, or rapidly. Most important trend has been toward higher operating temperatures, made possible by glass fiber and silicone insulation. Fairly extensive use is now being made of electronic variable-speed control. Most novel recent development in motors is probably the axial-air-gap design of Fairbanks, Morse which permits a much more compact motor installation. It is about 30 percent lighter and half the length of an average motor.

Air Conditioning . . . . . .

Except for minor mechanical changes, air conditioning has changed little in ten years. Axial flow fans are coming into use and trend is toward high-speed direct-connected refrigerating compressors. Until recently there was not much evidence of any increase in interest in non-refrigerated systems for dehumidification. There are several installations now being made, however, to use triethylene glycol for this purpose, to a large extent because of newly discovered germicidal effects that small concentrations of this chemical have recently been found to exert. It is probable that such installations will be of more interest in comfort conditioning than for industrial work outside the food and pharmaceutical field.

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Catalyst Manufacture—A Growing Industry

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Considerable research and development work has been performed on catalytic processes since Berzelius first named and defined catalysis in 1836. Although several industrial catalytic processes were adopted after 1868, it has only been within the past ten years that the industrial use of catalysis in chemical reactions has increased in such great extent that manufacture of catalysts themselves has become an industry.

A CATALYST is defined as a substance which, by its presence in a medium where a chemical reaction occurs, either increases or decreases the reaction velocity without being changed itself or appearing in the compound resulting from the reaction. Consequently, a catalyst may enter into a chemical reaction over and over again. Sometimes a catalyst will markedly accelerate one of a group of chemical reactions which normally take place at similar rates. Such a catalyst is termed selective with respect to the reaction it favors. The practical result of using a catalyst possessing both activity and selectivity for a given reaction is the ability to make the reaction industrially feasible and economically attractive. Yields are higher, conversions (and hence plant capacity) are higher, temperature levels of operation are lower with resultant lower process and maintenance costs. While in earlier days catalyst users developed and manufactured their own catalysts, in recent years appreciation of the economies and advantages of the ready-made catalyst has grown so that catalyst manufacture has itself become an industry.

A history of catalysis reflects many important milestones in the development of the chemical industry. The most significant catalytic chemical processes of industrial or technical importance have been listed in the accompanying tabulation (p. 128).

This list does not pretend to be complete but is illustrative of progress in industrial catalysis.

The recent heavy expansion of the chemical industry in the southwestern part of the United States (see *Chem. Eng.*, Nov. 1947) is based on the use of industrial catalytic processes.

In addition to the investment made by private industry, it became necessary during World War II for the United States Government through the Office of Rubber Reserve to spend approximately $700,000,000 in the erection and operation of plants for the manufacture of synthetic rubber by catalytic processes. Over 90 percent of the designed butadiene capacity and all of the styrene capacity in the government program employed catalytic processes.

A majority of the industrial catalytic processes require either what are commonly known as preformed catalysts or else catalytic chemicals such as anhydrous hydrofluoric acid, aluminum chloride anhydrous, antimony trichloride anhydrous, boron trifluoride and boron fluoride ethyl ether complex. Preformed catalysts usually consist of metals or metal oxides in the form of powders, spheres, granules, tablets, pellets or rings. In general, the geometrical shape of preformed catalysts is affected by the desire to get high mechanical strength in fixed bed catalysts.

The fluidized process for catalytic cracking uses a catalyst in the form of a powder or micro-spheres. In the fluidized process the powdered catalyst in the reactor is in a constant state of turbulence due to the forced passage of the oil vapors through the catalyst. Powdered catalysts are also used in liquid phase catalytic reactions which are usually conducted batch-wise. A typical example is the use of nickel

The Growing Industry's Value

Table I—Estimate of Major Catalyst Replacements in 1948*

Catalyst Use	Catalyst Base	Short Tons	Value
Synthetic cracking—all kinds	Silica	38,000	$10,000,000
Hydroforming	Alumina	1,800	3,200,000
Dehydrogenation for butadiene	Various	410	600,000
Fat hydrogenation	Nickel	75	250,000

* This table does not include catalysts used in the manufacture of ammonia, methanol and styrene. Preformed and prepared catalyst prices cover the range $0.12 to $1.65 per lb.

catalyst in the hydrogenation of oils and fats; when the reaction is completed the catalyst is separated by filtration. Preformed catalysts are used in fixed-bed catalysis. Here the catalyst is stationary in the reactor and the reactants are passed through the catalyst bed where the proper temperature and pressure are maintained for the most efficient operation of the process. In many cases the activity of the catalyst is impaired in time by the deposition of carbonaceous material which is burned off the catalyst bed by combustion with air under carefully controlled conditions.

Listed in the accompanying tabulation are some of the more important industrial catalytic processes currently being used in the petroleum, synthetic rubber, chemical, natural gas and fat processing industries.

The most important properties of preformed catalysts are activity, selectivity, catalyst life, mechanical and thermal stability, crushing strength, porosity, bulk density, surface area, and corrosive and erosive properties. The suitability of a catalyst for a reaction is usually determined by its chemical composition. Catalyst activity is basically affected by porosity and surface area. The selectivity of the catalyst is usually dependent on the addition of promoters or retarders to the basic catalyst. The bulk density, mechanical stability and porosity are controlled in the manufacture by suitable choice of the method of forming and the nature of the carrier or support used.

Catalyst life is dependent to a great extent upon the nature of the process, the chemical nature of the materials being processed and their freedom from catalyst poisons. Accurate control during both the process run and the alternating regeneration of the catalyst is necessary to avoid unduly rapid deterioration of the catalyst by incomplete carbon or tar burn off, spalling, or fusion of the catalyst surface. Consequently, a catalyst manufacturer must have an intimate knowledge of and wide experience in the manufacture of the various inorganic chemicals which are used as raw materials in the manufacture of catalytic materials.

Who Makes Them

The economic importance of this preformed catalyst industry is indicated by the fact that annual gross sales for replacements only in 1948 in the major fields of consumption are estimated to exceed $14,000,000 (see table on p. 127).

American Cyanamid & Chemical Co. manufactures an alumina silica

CATALYSTS: Their History

1868—Production of chlorine from hydrochloric acid and air using broken clay brick impregnated with cuprous chloride.

1875—Oxidation with air of sulphur dioxide to sulphur trioxide in the presence of platinum on asbestos.

1882—Oxidation with air of methyl alcohol to formaldehyde with platinum or metallic copper foil.

1885—Oxidation with air of hydrogen sulphide to sulphur using hydrated ferric oxide.

1895—Production of phthalic acid by oxidation of naphthalene in the presence of mercury.

1898—Substitution of iron oxide for platinum in the sulphur trioxide process.

1901—Addition of calcium chloride in the combination of nitrogen with calcium carbide to form cyanamide.

1902—Hydrogenation of oils and fats in the liquid phase using nickel.

1903—Production of nitric acid by oxidation of ammonia in the presence of platinum.

1907—Production of hydrazine from monochlproamine with ammonia or by treating a hypochlorite with excess ammonia.

1908—High pressure synthesis of ammonia using iron, nickel, chromium and manganese.

1910—Acetaldehyde from acetylene using mercuric oxide.

1910-14—Development of the Bosch process for high pressure synthesis of ammonia.

1913—Production of hydrogen from carbon monoxide and water using nickel and cobalt. Development of the Fischer-Tropsch process for preparation of various organic compounds by reduction of carbon monoxide in the presence of nickel, cobalt and similar substances. Hydrogenation of nitrobenzene to aniline using copper.

1914—Ammonia oxidation with iron oxide—bismuth oxide.

1916—Preparation of phthalic acid and anthraquinone by partial oxidation of napthalene and anthracene respectively using vanadium pentoxide or molybdenum trioxide.

1917—Catalytic oxidation of hydrogen sulphide by means of activated carbon in the presence of ammonia.

1918—Carbon monoxide oxidation at ordinary temperature by means of Hopcalite (copper-manganese oxide, copper, manganese-silver oxide).

1923—Synthesis of methanol using hard-to-reduce metal oxides such as zinc oxide plus chromium oxide or zinc oxide plus chromium oxide plus manganese oxide.

1924-25—Production of hydrocyanic acid from carbon monoxide and ammonia or formamide in the presence of copper, brass or aluminum.

1928—Clay treating of gasoline for gum improvement.

1933—Catalytic dehydrogenation of paraffin hydrocarbons.

1935—Catalytic dehydrogenation of ethyl benzene to styrene.

1936—Catalytic cracking of petroleum.

1939—Sulphuric acid alkylation process for isooctane.

1941—Hydroforming of petroleum for toluene.

1941—Aluminum chloride isomerization of normal butane to isobutane.

1942—Hydrofluoric acid alkylation process for isooctane.

1943—Catalytic conversion of alcohol to butadiene.

1943—Catalytic dehydrogenation of butenes to butadiene.

1944—Aluminum chloride alkylation process for diisopropyl.

1944—Catalytic dehydrogenation of butane to butenes.

1944—Synthesis of mercaptans from olefins and hydrogen sulphide.

1947—Catalytic hydrogenation of dextrose to sorbitol and mannitol.

1947—Ion exchange resins to catalyze esterification processes.

CATALYSTS: Their Uses

Reaction	Process	Typical Catalyst
PETROLEUM INDUSTRY		
Cracking	Fluid	Synthetic alumina-silica, natural clay
	Thermofor	Synthetic alumina-silicia, natural clay
	Houdry	Synthetic alumina-silica, natural clay
	Cycloversion	Bauxite
Hydroforming	Naphtha octane improvement	Molybdena-alumina
	Aromatics manufacture	Molybdena-alumina
Desulphurization	Union Oil Company	Cobalt molybdate
	Phillips Petroleum Co.	Bauxite
Polymerization	Universal Oil Products Co.	Phosphoric acid—kieselguhr
	M. W. Kellogg Co.	Copper pyrophosphate
Isomerization	Shell Oil Co.	Aluminum chloride plus antimony trichloride
Hydrogenation		Nickel
Alkylation		Anhydrous hydrofluoric acid and sulphuric acid
Dehydrogenation		Chrome-alumina
SYNTHETIC RUBBER INDUSTRY		
Dehydrogenation	Butylene production and butadiene production	Chrome-alumina and promoted iron oxide
Alkylation	Ethylbenzene	Silica-alumina
Dehydrogenation	Styrene	Promoted iron oxide, zinc oxide-alumina and magnesia-iron-copper
CHEMICAL INDUSTRY		
Oxidation	Maleic anhydride	Vanadium pentoxide
	Phthalic anhydride	Vanadium pentoxide
	Formaldehyde	Iron molybdate and silver
Hydrogenation	Methanol synthesis	Zinc chromite
	Ammonia	Iron oxide
	Esters to alcohols	Copper chromite
	Unsaturated hydrocarbons to saturated hydrocarbons	Nickel
	Conversion of nitro compounds to amines.	Nickel
Esterification		Ion Exchange Resins
		Sulphuric acid
Dehydrogenation	Conversion of saturated hydrocarbons to unsaturated hydrocarbons	Chrome-alumina and promoted iron oxide
Dehydration	Dehydration of alcohols	Alumina
	Amines from alcohol and ammonia	Alumina
Polymerization		Organic peroxides
NATURAL GAS INDUSTRY		
Reforming	Carbon monixide and hydrogen	Nickel
Water gas reactions	Carbon monoxide and hydrogen	Iron oxide-magnesia
Fischer-Tropsch	Hydrocarbons and oxygenated compounds from water gas	Iron oxide and cobalt thoria
FAT AND FATTY ACIDS INDUSTRY		
Hydrogenation	Solid fats and fatty acids	Nickel
	Rosin acids and esters	Copper chromite

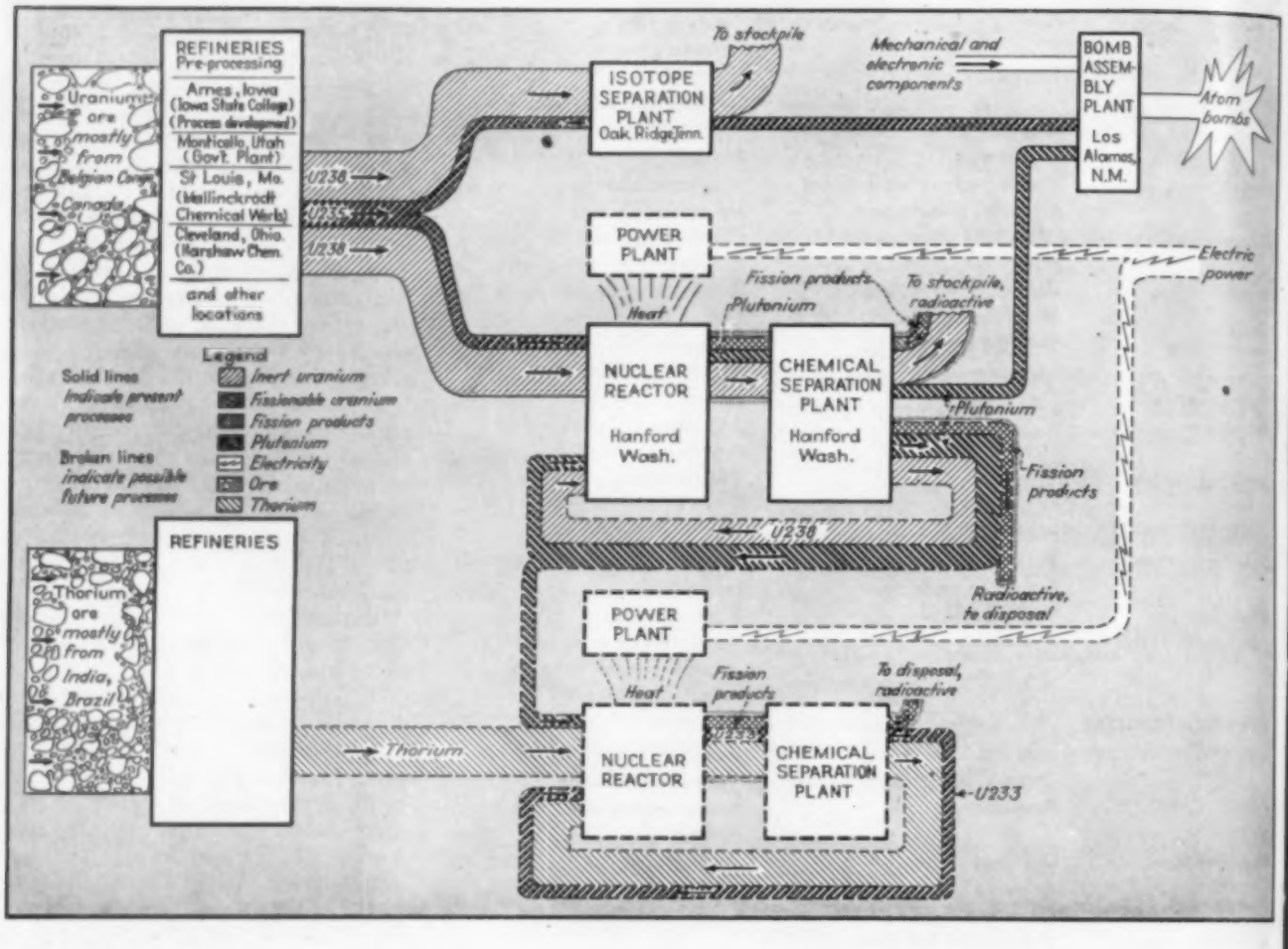
catalyst for use in the fluid catalytic cracking process and in addition manufactures a vanadium pentoxide catalyst in tablet form for the manufacture of sulphuric acid. Through its subsidiary, Chemical Construction Corp., American Cyanamid also offers iron oxide ammonia synthesis catalyst, nickel catalyst for gas reforming, and promoted iron oxide catalyst for carbon monoxide conversion in the manufacture of ammonia from natural gas. American Cyanamid has recently acquired a surplus war plant at Fort Worth, Tex., which they had operated for the government for the manufacture of alumina-silica cracking catalyst.

Davison Chemical Corp., Baltimore, Md., manufactures an alumina silica catalyst for the fluid catalytic cracking process as well as an alumina silica catalyst for the manufacture of ethyl benzene for styrene from benzene and ethylene. This concern recently purchased a war surplus plant at Cincinnati, Ohio, for catalyst manufacture. In addition, Davison has recently announced a tableted vanadium pentoxide catalyst on a silica base for catalytic oxidation reactions.

Harshaw Chemical Co. manufactures catalytic chemicals such as anhydrous hydrofluoric acid, anhydrous hydrogen chloride, anhydrous aluminum chloride, antimony trichloride, boron trifluoride and its diethyl ether complex. Harshaw has also been a pioneer in the development of preformed solid catalysts in powdered, tableted, extruded and granular form which find industrial use in dehydration, dehydrogenation, hydrogenation, hydroforming, oxidation and other similar types of operations.

Filtrol Corp. manufactures a pelleted clay catalyst for use in fixed-bed catalytic cracking. Filtrol also offers an activated bentonite catalyst. Girdler Corp. manufactures a variety of catalysts essentially for use in equipment of their design and construction for the processing of gases particularly for the manufacture of hydrogen. Houdry Process Corp. manufactures a pelleted alumina-silica catalyst for catalytic cracking and a chrome-alumina catalyst for the Houdry butane and butylene dehydrogenation process. M. W. Kellogg played a prominent part in the development of the hydroforming process using a molybdena-alumina catalyst which they now manufacture. In addition, Kellogg makes a copper pyrophosphate catalyst for olefin polymerization. Oronite Chemical Co. produces a tableted molybdena-alumina gel base catalyst for hydroforming. Socony Vacuum Oil Co. makes the alumina-silica bead catalyst for catalytic cracking.

Where Do We Stand O[illegible]h



OUR PROCESSES: We've finally got organized on research—better bombs, better processes.
OUR PLANTS: Here too we're rolling again. Hanford hums with expansion, pepped-up morale.

Y-12: The Quick Plant—First to produce but inherrently expensive to operate. Now reduced to standby status.

K-25: The Successful Plant—Still going strong, still no hitch. But Pasco plutonium process is more economical.

Pasco: The Promising Plant—A hellion to control but best bet for future. Expansion underway: $300-500 million.

The Atom?

ROBERT COLBURN
Washington Bureau
McGraw-Hill Publishing Company

What are the facts about America's atomic energy program? It affects the lives and hopes of all of us. Yet it is clothed in secrecy that breeds misunderstanding, rumors and recriminations. To penetrate into this "Battle in the Dark," the McGraw-Hill Atomic Energy Committee has sent an able, experienced reporter on an inspection of all AEC activities and facilities. His present critical report brings us up to date on developments since he made his first round-up for us in March 1947.

For the business man or engineer trying to gage the eventual impact of atomic energy on his industry, for the citizen trying to form an intelligent opinion on this national issue, the facts are extraordinarily hard to come by. The information that anyone would naturally ask for—on production rates, costs, resources, and the like—is all stamped "Top Secret." Even the nature of the problems ahead, the technical reasons for policy decisions, the terms of contracts, are obscured, if not hidden, by secrecy requirements.

In this situation, the Washington Bureau of *Chemical Engineering* has examined the whole atomic energy program, starting from a background of close coverage of the subject ever since Hiroshima. We didn't ask for, and didn't get, any secret information. But we have talked to government officials, both in and out of the Atomic Energy Commission. We have visited every major plant and laboratory. We have conferred with industrial leaders —both those involved in the atomic energy program and those who have chosen not to be involved.

Briefly, these are the conclusions we have reached:

The Short Run—The atom management's No. 1 job, of course, is to keep the war-built plants running, to maintain the bomb production achieved by the Manhattan District. On this there has been no faltering, no interruption of production. At Oak Ridge, efficiency in the separation of fissionable uranium has been greatly stepped up. At Hanford, production of plutonium has been achieved in the face of great technical obstacles. At Los Alamos, manufacture of the electronic and mechanical apparatus of the bomb has been headed from a laboratory toward a factory operation.

The Long Haul—Equally important with operation of existing plants is the job of advancing the atomic art—which means producing better weapons, finding out more about atomic fundamentals. At this level, no unqualified endorsement, such as the short-term job has earned, can yet be given to the government's atom program. Six months ago it would have been necessary to report that the forward-thrusting phase of atom work was in a state of near stagnation. For example:

Preparations for a new and bigger plutonium plant—AEC's highest priority project—were enmeshed in engineering and personnel difficulties.

Weapons research was at loose ends. It was operating in a vacuum without guidance from either the military or the AEC.

Construction of new types of atomic reactors, the key devices for utilization of nuclear fission, was being held up by vacillation and indecision in AEC.

Throughout the whole project, morale was low. Many technical men were leaving; many of those who remained were discouraged and uncertain. They were conscious of a lack of direction and impetus. Unable to get Washington approval on new programs, they often were reduced to marking time.

On the Mend

That was late last summer. And that was the bottom. At just about that time, the year-old AEC began to get a grip on its huge job. Things began to improve. Today the situation is still spotty, good here, bad there, but everywhere it is visibly on the mend.

An early and fruitful step was the appointment of an able group of regional administrators who could give local leadership to the atom projects. These men were granted a large measure of autonomy. At Hanford and Oak Ridge, for instance, the local men can OK expenditures up to $5 million without reference to Washington; this is almost unprecedented in government. And this frees the operating contractors at the site from a tremendous amount of waiting on Washington.

Additional contractors were brought in to strengthen the design forces on the new plutonium plant at Hanford, and this program is now rolling. Design is well along; preliminary construction work is already under way and will reach a new high level later this year. The whole Hanford project radiates verve and enthusiasm for the job.

Weaponeering at Los Alamos still has a long way to go to match the drive of Hanford. But at least a research program has now been agreed on among AEC, the military, and the scientific laboratory, and the laboratory is squaring away to undertake its research.

Similarly, in the reactor program, the designers are ready to go now on three or four new piles that have been awaiting the nod from Washington for a year or more. In a radical reorganization of the reactor program, work that had been divided between Clinton Laboratory at Oak Ridge and Argonne National Laboratory at Chicago has now been concentrated at Argonne.

The program which AEC has now taken off dead center is above all things an armament program. Civilian applications of atomic energy get the publicity, but bomb production gets the money—around 80 percent of AEC's annual $600 million. Real insiders don't talk about bomb output; outside guessers seem to agree, though, that talk of production rates in the hundreds and thousands is fantastic.

Where Do We Stand, Plantwise?

The United States came out of the war with an atomic bomb industry consisting of four major plants: two at Oak Ridge to separate the isotopes of uranium, one at Hanford to produce plutonium and one at Los Alamos to assemble bombs using atomic explosives.

Y-12: The Quick Plant—The first plant to deliver appreciable quantities of explosive was the electromagnetic, or Y-12, plant at Oak Ridge, originally operated by the Tennessee Eastman Corp. This plant contains a large number of machines, calutrons, each of which is capable of producing U-235. But each individual machine has a low output, the power consumption is very high, and the manpower re-

quired to produce a pound of material is all out of proportion with alternate methods.

So early last year large-scale production at Y-12 was halted. Most of the plant is being held in standby condition. Some of the calutrons are being operated experimentally to find a way around the low efficiency of the process. Several others have been converted to separate isotopes other than uranium.

On this basis, the plant is being looked after by Carbide and Carbon Chemicals Corp., which now operates all the major facilities at Oak Ridge.

K-25: The Successful Plant—The second and best known of the U-235 plants is the gaseous diffusion operations at Oak Ridge. It is believed to be the largest industrial project ever carried on under one roof. Its construction involved fantastic difficulties. It cost a billion dollars to build. It's the only one of its type in the world. And in all probability there will never be another one like it.

K-25 has been by far the most successful of the atom plants. Almost from the start it ran without serious difficulties. Nevertheless, AEC feels that technically K-25 is a blind alley. For one thing, it is the most expensive and difficult to build of all the plant types. More important, it is intrinsically wasteful of nuclear fuel. (It extracts the naturally fissionable 0.7 percent from uranium and discards the rest.) The Hanford process, on the other hand, offers the promise of utilizing the plentiful kind of uranium, U-238, by transmuting it into the fissionable element, plutonium.

While there are no plans for additional facilities of its type, K-25 itself will be kept running indefinitely, certainly as long as accumulation of bombs has a top priority. And even after that, there'll be uses for concentrated U-235. Production of enriched fuel, for instance, for certain types of reactors, will certainly be needed. And there are hints that the uranium bomb is in some ways superior to the plutonium bomb.

Meanwhile, the K-25 process has been steadily improved since the end of the war. The basic design has not been changed, but many shortcuts and equipment changes have been made gradually. Output of U-235 has been substantially increased and labor requirements have been reduced from a peak operating force of 12,000 down to a present 5,200.

Pasco: The Promising Plant—No such postwar increase in output has been achieved at the third atom plant—the Hanford Engineer Works. Some figure it's a technical miracle that production has even been held to the wartime level. Where K-25 applied fairly well established industrial principles, albeit on a plane of extreme complexity, the three Hanford units utilize processes that had never occurred on earth until December 1942. The designers of the three Hanford piles had only one motive: to make plutonium for a bomb. If the piles continued to operate afterwards, so much the better. But they were not wasting much thought on that question. Few of them, probably, would have bet that the piles would still be running in 1948.

Shortly after the chain reaction in the first pile was turned on, there was one terrible day when the reaction simply died away, spontaneously. Fission products were "poisoning" the pile. In what has been described by people who were there as the most brilliant single feat of engineering they know of, the trouble was diagnosed and a solution found within a matter of hours.

They have had a succession of lesser crises since. As recently as last year it was at times a question of how many more months the piles could be kept going.

The Hanford process strikes out on a completely different tack from Oak Ridge's. No effort is made at the tough separation of U-235 from U-238 which, as isotopes, are chemically identical and offer only a tiny weight difference to work on. Instead, the U-235 is "burned up" in a chain-reacting pile. In its burning, it transmutes a little of the U-238 into another element, plutonium. Pu is fissionable and, most important, it differs chemically from uranium. So then the plutonium can be separated by exceedingly difficult but comparatively straightforward chemical methods.

The plutonium leaves a problem behind it—in the form of tons and tons of a mixture of working chemicals, water, uranium and fission products. These last possess radioacitvity which takes years to die away and is so intense that it contaminates the whole mass to the point where it must be handled from behind lead or concrete walls.

At present this deadly mess is simply stockpiled for later extraction of the uranium. But proper storage is tough. Leakage could contaminate the water-supply of the whole region although AEC is confident that the measures it takes obviates any danger.

So grave is this difficulty, however, that it has been seriously argued that waste disposal dangers might make permanently impossible the use of any large number of high-powered chain reactors. Actually, the situation isn't thought to be as bad as that. The solution seems to lie in more complete chemical treatment of the pile output, treatment which would separate out the fision products. These add up to a matter of pounds rather than tons, and their disposal would not be so frighteningly difficult.

Despite all its difficulties, the plutonium process is the one on which everyone banks for the future. So AEC has started a tremendous expansion program at Hanford as its major move to step up bomb production.

One part of the program is just to modernize the three existing units—particularly, one assumes, in their chemical engineering phases. But the really big job is the construction at Hanford of a complete new plutonium plant. It will be bigger—or at least more expensive—than the existing plant and will presumably have a larger production capacity. Eventual cost will be something between $300 and $500 million—making it the biggest single construction job ever undertaken in peacetime.

New Hanford Plant

The new plant isn't going to differ fundamentally from the old one. It will use fairly conventional graphite-moderated piles with natural, rather than enriched, uranium. Most important, the piles will run cold rather than at the high temperature which would permit utilization of their tremendous power output—even though this means throwing another million kilowatts or so into the Columbia River.

General Electric has taken on the operation, succeeding Du Pont, which had designed, built and operated the plant during the war. G. E. inherited a crack operating staff from Du Pont; nearly every man elected to stay with the project when the transfer was made. But G. E. inherited no engineering staff. In the Du Pont tradition, Hanford was designed by the central engineering force at Wilmington.

Thus G. E. had to assemble an engineering force at Hanford at the same time that it tackled one of the biggest design jobs in history. Good engineers are hard to come by these days. And all through last summer, AEC kept scaling up its ideas about the size of the plant. But last September the bottleneck was broken. G. E. subcontracted the design of the chemical separation plants to Kellex Corp., the M. W. Kellogg subsidiary which designed K-25 at Oak Ridge.

At the same time another subcontract was placed with Standard Oil Co. (N. J.) to work out alternate designs for several particularly tricky phases of the chemical plants. Still a third alternative is being explored by the Clinton Laboratory at Oak Ridge.

Today design is well advanced. Guy F. Atkinson and J. A. Jones Construction Co., G. E. construction subcontractors, already have preliminary work under way. By the end of the year it will be going full blast and will continue at a high rate until it begins to taper off in 1951. Material procurement for the new plant is already moving. This is proving, in many ways, to be more difficult than it was during the war.

Curiously, it isn't the tricky special items that cause the trouble. The unique, utterly special equipment, is being obtained fairly easily from the same people who furnished it during the war. Electronic controls and instrumentation are not proving much of a headache. There are also a lot of things like corrosion-resistant tubing on which special deliveries can be had from firms which regularly supply the chemical process industries.

Where the trouble comes is in getting standard stuff—steel (of which 54,000 tons will be needed), lumber, cement. Some idea of the quantities involved may be gained from the statistics on the present plant, which required 25,000,000 cu. yd. of excavation, 780,000 cu. yd. of concrete, 160,000,000 b. ft. of lumber, 232 mi. of pipe. Regular supply lines into the Northwest just aren't able to absorb quantities like these. In some cases the purchasing agents have had to resort to the grey market.

Morale on the Mesa

Los Alamos Scientific Laboratory, perched on the flat top of a mesa in Northern New Mexico, is the plant for actually manufacturing bombs from the explosive produced at Hanford and Oak Ridge. So far, Los Alamos looks like the weakest spot in AEC's program for more and better bombs.

The weakness isn't in the actual day-by-day assembly of bombs. That has been steadily improved and is in good shape. The processes have been standardized and mechanized. No longer is assembly of each bomb a laboratory job for trained scientists. But that is only a small part of Los Alamos' responsibility. Its real job is to produce a better bomb. And so far, one gathers, no very startling progress has been made in this direction.

Part of the responsibility for this traces to Washington. Until a month or so ago, no definite research program had been worked out for Los Alamos, either by AEC or by the Army before it. The whole responsibility for the direction of weapon work rested on the men on the mesa.

And that responsibility fell on an organization in poor shape to handle it. Like every war agency, the atom project suffered a considerable exodus of its best men at war's end. But nowhere was this more marked than at Los Alamos. The laboratory is pretty much down to its second team —and worse, is self-conscious about the fact. There were a lot of reasons for the break-up. At Los Alamos more than anywhere else, a scientist unavoidably had his nose rubbed in the fact that he was first and foremost a weapon-maker. And although the laboratory is one of the best-equipped in the world, its work was heavily "programmatic," aimed at specific results rather than basic knowledge.

AEC is making a vigorous effort to attack the problem at its source. Its new program provides for devoting about a quarter of the laboratory's resources to basic research to make the place more professionally attractive. A building program, to replace the makeshift housing with modern homes in a charming version of southwestern architecture, complete with shopping and recreation centers, is being pushed at top speed. Within a year or two Los Alamos will be an almost luxurious resort-type town. The AEC campaign at Los Alamos is a long range affair. The answer to whether it will pay off in bombs is months or years away.

Power Problems

During the past year a number of technical problems standing in the way of atomic power production have come close to solution. On the problem of a heat-transfer fluid, of which much was heard a year ago, it now looks as if the Smyth report's suggestion of liquid sodium, alloyed with potasium to lower its melting point, would turn out well. Sodium doesn't absorb neutrons, does not become seriously radioactive, has good thermal properties. It does react violently with water. However, a special heat exchanger has been developed—somewhat complicated but workable—to obviate trouble from this source.

Nor does the problem of structural materials for reactors now look as appalling as it did a year ago. Metallic titanium is being considered as a major load-carrying material which could resist pile temperatures that may eventually run, it is thought, as high as 2,000 to 2,500 deg. F. AEC metallurgists are studying structural properties of a lot of other metals, such as beryllium and zirconium, which in the past have been used mainly as alloying agents. Some of these have nuclear properties which make them valuable in themselves. And this work is already producing valuable byproducts. Discovery of ways to roll and extrude beryllium, for instance, has resulted in improved windows for X-ray tubes.

Similarly, the elaborate chemical engineering studies involved in the design of the new Hanford plutonium plant are expected to develop separation methods basically applicable to atomic power plants as well as to plutonium producers.

Fuel Breeds Fuel

During the last year, too, declassification of information on the breeding problem has clarified one fundamental question: Is nuclear fuel so scarce that atomic energy must always be regarded as a special-purpose affair to be rigidly conserved? Or is it plentiful enough to be regarded as a major power resource? Uranium itself is a fairly plentiful metal. However, only one part in 140 of it is naturally fissionable. If that were all, atomic energy would be a rarity very soon. But when fisionable U-235 is consumed in a reactor, producing power in the process, some of the U-238 is transmuted into fissionable plutonium. This increases the potential supply of fuel.

The same thing applies to thorium, which is more plentiful than uranium. Exposed to a chain reaction, thorium is transmuted to fissionable U-233.

Theoretically, it is possible for fuel to breed fuel. When a U-235 atom splits, it throws out, on the average, something more than 2.2 neutrons. One of these is needed to split another U-235 atom and keep the chain reaction going. If another neutron is used to transmute a U-238 atom into plutonium, that leaves a margin for losses —if the losses are small enough.

AEC's guarded comments indicate that in present piles the neutron losses are too great to permit breeding. But it is believed that the new piles now on the drafting boards would be effiicient enough to breed fuel.

If it works out, that makes atomic energy a thousand-year resource or better. And people who like to worry about the fate of their descendants fifty generations away can take comfort from this thought: although there is no reason to look for coal or oil there, the moon should have lots of uranium and thorium.

1948 Committee of Award for CH

Alfred Holmes White
Michigan's distinguished Professor-Emeritus of Chemical Engineering continues as chairman of this committee of leading educators who will designate the winner of the 1948 Award for Chemical Engineering Achievement.

C. P. Baker
Northeastern

W. H. Beisler
Florida

C. F. Bonilla
Johns-Hopkins

R. M. Boarts, Jr.
Tennessee

G. L. Bridger
Iowa State

H. F. Jo
Illino

G. G. Brown
Michigan

A. P. Colburn
Delaware

L. S. Coonley
Rensselaer

A. H. Cooper
Bucknell

Jas. Coull
Pittsburgh

J. W.
Georgi

D. S. Cryder
Penn State

B. F. Dodge
Yale

C. G. Duncombe
Detroit

O. E. Dwyer
Rochester

J. C. Elgin
Princeton

Geo. Glockler
Iowa Univ.

A. J. Hartsook
Rice Inst.

A. H.
Cooper

Chas. Hecker
Clarkson

A. W. Hixson
Columbia

P. M. Horton
Louisiana

O. A. Hougen
Wisconsin

R. M. Hubbard
Virginia U.

W. J. Huff
Maryland

R. L. Huntington
Oklahoma

F. C. V
Virgin

TO RECOGNIZE GROUP EFFORT in the Chemical Process Industries

Previous Recipients

1933 Carbide & Carbon Chemicals Corp.
Synthetic Aliphatic Chemicals

1935 Organic Chemicals Dept., E. I. duPont de Nemours & Co., Inc.
Synthetic rubber from acetylene, camphor from turpentine

1937 Monsanto Chemical Co.
Large-scale production of elemental phosphorus

1939 Standard Oil Development Co.
New aviation fuels and petrochemicals

1941 The Dow Chemical Co.
Magnesium from sea water

1943 The American Synthetic Rubber Industry
A vital wartime accomplishment

1945 The Atomic Bomb Project
War-ending achievement

1947 Merck & Co., Inc.
Streptomycin and vital medicinals

Next November, following the annual meeting in New York of the American Institute of Chemical Engineers, the ninth Award for Chemical Engineering Achievement will be presented to the company—or department within a company—in the process industries which, in the opinion of the 1948 award committee, has contributed most to the advance of the industry and profession. The sponsor's decision to change this award to an annual basis was prompted by the increasing tempo of postwar progress as so many important chemical engineering developments are coming into commercial fruition. The prime purpose of this unique award, which was established in 1933, is to recognize group effort by focusing public attention on those progressive companies that have encouraged their chemical engineers to participate broadly in all phases of the process industries.

Nominations are in order. As in the past, the Committee of Award will welcome comments, criticisms and suggestions from all readers of *Chemical Engineering*. Address your communications to S. D. Kirkpatrick, Secretary, Committee of Award, Room 2400, 330 W. 42nd St., New York 18, N. Y.

CHEMICAL ENGINEERING ACHIEVEMENT

H. F. Johnstone
Illinois U.

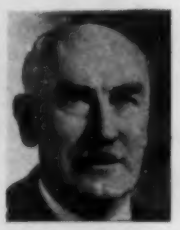
K. A. Kobe
Texas U.

W. N. Lacey
Cal. Tech.

J. D. Lindsay
Texas A. & M.

J. R. Lorah
Missouri

C. D. Luke
Syracuse



C. A. Mann
Minnesota

J. W. Mason
Georgia Tech

M. C. Molstad
Pennsylvania

C. C. Monrad
Carnegie Tech

R. W. Moulton
Washington

H. A. Neville
Lehigh

D. F. Othmer
Brooklyn Poly.

C. F. Prutton
Case

A. H. Radasch
Cooper Union

F. H. Rhodes
Cornell

J. H. Rushton
Illinois Tech

R. N. Shreve
Purdue

L. D. Stratton
Drexel

R. S. Tour
Cincinnati

R. E. Treybal
New York U.

F. C. Vilbrandt
Virginia Poly.

J. S. Walton
Oregon State

W. G. Whitman
M.I.T.

E. D. Wilson
Worcester

C. G. Williams
Louisville

J. R. Withrow
Ohio State

S. D. Kirkpatrick
Secretary

Rules and Conditions Governing the Ninth Award for Chemical Engineering Achievement

1. The purpose of this award is to encourage a broader participation of the chemical engineer in the affairs of the process industries by giving public recognition to that company which through coordinated group effort has contributed most to the advance of the industry and profession. This ninth award will apply only to industrial developments that have come into commercial fruition or become publicly known since August, 1945.

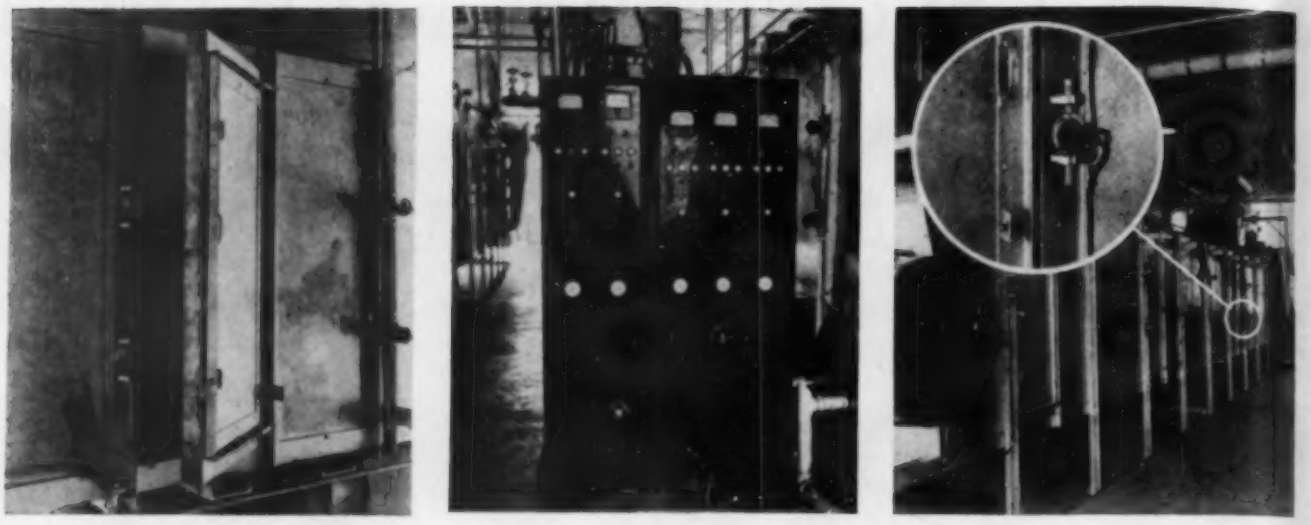
2. The award will consist of an appropriate bronze plaque suitably engraved to indicate the nature of the achievement and the name of the company to which it is presented. The award will be presented at a dinner of the chemical engineering profession in New York during the week beginning Nov. 7, 1948.

3. The award is to be made to a company rather than to any individual within a company, since it is primarily a recognition of group effort. However, any subsidiary or department within a corporate organization might be eligible for the award on the basis of special achievements brought to the attention of the Committee of Award.

4. The Committee of Award shall consist of the heads of chemical engineering in all of the educational institutions of the United States whose courses as of May 1, 1948, have been accredited by the American Institute of Chemical Engineers and the Engineers Council for Professional Development. Dr. Alfred H. White, Professor-Emeritus of Chemical Engineering at the University of Michigan, and member of the Award Committee since its inception in 1933, will continue to serve as chairman. The editor of *Chemical Engineering* will continue as secretary but without vote.

5. Any company in the process industries desiring to be considered for this award is urged to submit, in confidence, the following information:
   (a) What is the nature of the achievement?
   (b) During what period has it come into commercial fruition?
   (c) To what extent have chemical engineers participated in its development?
   (d) Any supplementary records, data, articles or references which are pertinent to a fair consideration of this achievement and of the company's attitude toward its chemical engineers?

6. This award is not restricted to those companies that file formal applications with the committee. Suggestions are desired from any and all sources that will assist the committee in directing attention to industrial groups that should have its consideration. Communications should be addressed to S. D. Kirkpatrick, Secretary, Committee of Award, Room 2400, 330 W. 42nd St., New York 18, N. Y.



DRYERS ARE PROTECTED by explosion doors (left), continuous vapor analyzer (center), and grounded rollers (right).

Safety Plus Built Into Pyroxylin Coating Plant

TO HANDLE NITROCELLULOSE AND FLAMMABLE SOLVENTS WITH MINIMUM RISK, ENGINEERS COME UP WITH A COATING PLANT THAT'S "SUPER SAFE"

HERBERT ROSENBERG
Chemical Engineer
American Finishing Co.
Memphis, Tenn.

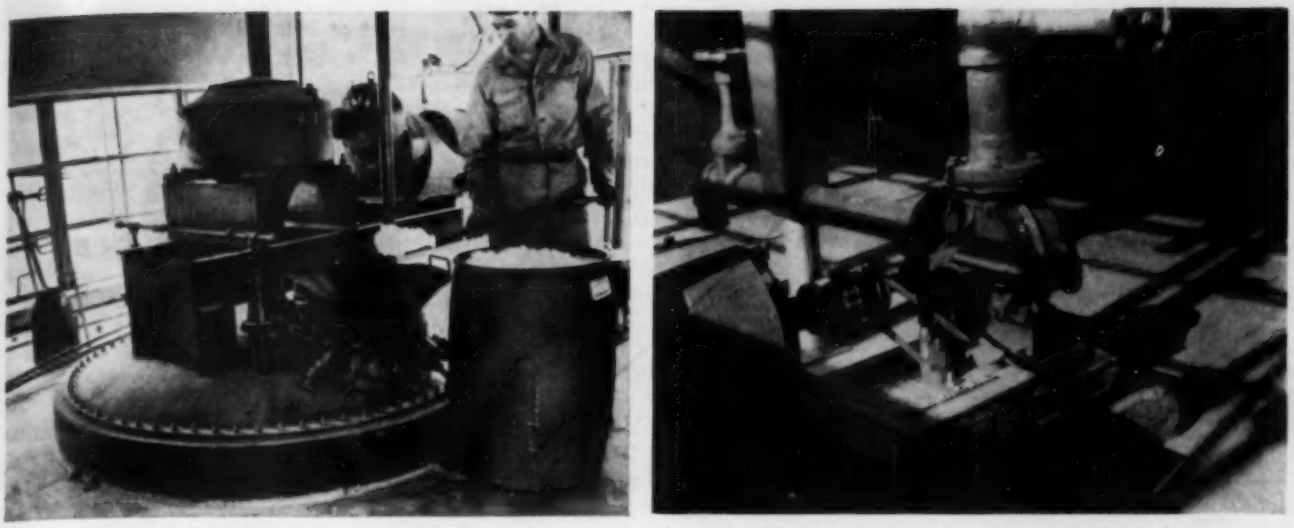
KID GLOVES are not enough when it comes to handling nitrocellulose. No one knows this better than the engineers who designed the new plant at Memphis, Tenn., where the American Finishing Co. manufactures pyroxylin-coated cloths. As they labored at their drafting boards the lives of the men and women who would work in the finished plant were uppermost in their minds. They put every safety feature they knew into this modern coating plant, one of the safest of its kind in operation today.

Safety was an important consideration in the choice of location. It was finally decided to build on land next to the existing finishing plant. The plant site covers about 10 acres. A large enough plot was selected to permit adequate dispersal of the units of the coating plant. With this area available, it was also possible to locate the units so that other buildings put up in the future would not create congestion and unnecessary risks.

A railroad spur was constructed at the west end of the plant. Packaged materials are unloaded at one point along this spur and transported by mechanical equipment to warehouses. Tank cars containing such liquid raw materials as solvents, diluents and oils are unloaded at another point along the spur. At this tank car unloading station both rails of the track are grounded to dissipate any static that might build up on a tank car or the surface of the liquid it contained. A swinging-type bridge gives access to the dome of a tank car. To unload a tank car containing a flammable liquid, a top connection is made and the tank emptied by a pump with an adequate suction lift. Adjacent to the spur at the tank car unloading station there is a pump house where such pumps are located.

This pump house is of fire-resistant construction. There is a separate pump for each solvent or diluent received. All are rotary pumps driven by Class I, Group D, explosion-proof motors. These pumps were carefully selected for this service. There is little leakage at their stuffing boxes and hence a complete absence of solvent odors in the pump house. Nevertheless, as an additional safety measure, in the wall behind the battery of pumps a ventilating fan is installed near the floor. It prevents the accumulation of solvent vapors in the building.

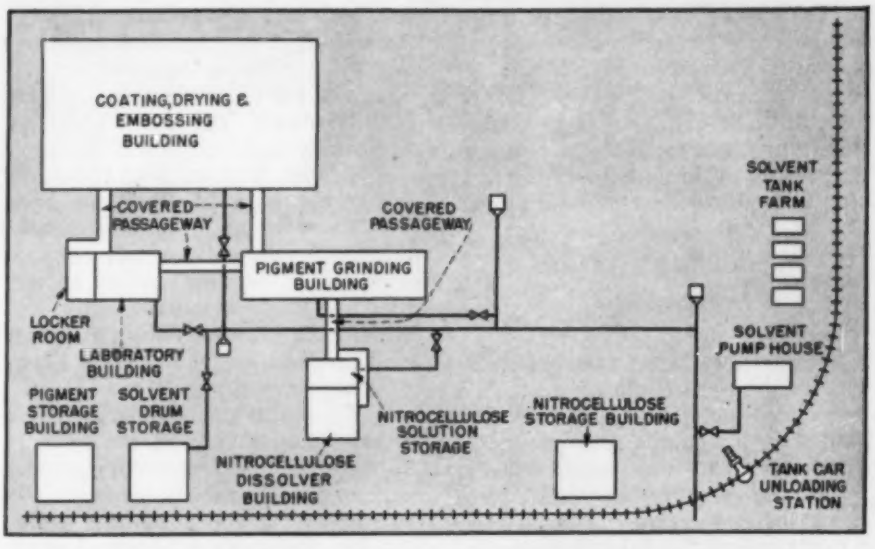
• About 35 ft. east of the pump house is a tank farm for above-ground storage



NITROCELLULOSE IS HANDLED with care in dissolver charging (left) and in solution pumps (right)

of solvents. The 12,000-gal. tanks rest upon concrete piers. The tank farm is completely inclosed by an earth embankment. The capacity of the inclosure exceeds the combined capacity of the tanks by 50 percent. Each tank is grounded at two points to dissipate static. Suction and discharge connections go through the top of each tank. The fill connection also goes close to the inside bottom to prevent "static spray." The vent of each tank is equipped with a flash arrester approved by the Underwriters' Laboratories and a combined pressure-vacuum relief valve. The storage tanks are also equipped with non-sparking rodding connections. Pumps in the pump house take suction from these tanks and deliver to the nitrocellulose dissolver building and also to the pigment grinding building. All flanged joints of pipelines and equipment carrying solvents or diluents are jumpered. The lines are grounded to low-resistance grounds at frequent intervals. All valves in the solvent piping system are cast steel. They are of the outside screw and yoke type. Both cast iron and non-indicating valves have been avoided for safety reasons.

The nitrocellulose storage building, in which barrels of alcohol-wet nitrocellulose are stored, is likewise of fire-resistant construction. It is located about 85 ft. north of the pump house. The lighting in this building is also Class I, Group D, explosion-proof. The floor is non-sparking and conductive; the walls are equipped with wooden waling pieces to keep the barrels out of contact with the masonry. From this storage building the barrels of nitrocellulose travel 80 ft. north by truck to the nitrocellulose dissolver building.



BUILDINGS ARE DISPERSED over the plant site's ten acre area and . . .

. . . large explosion walls of scored glass add still another safety feature

The dissolver building is a two-compartment building of fire-resistant construction. The dissolver and related equipment are located on one side of the fire partition; storage tanks for the nitrocellulose solution are on the other side. Both the ground floor and the mezzanine or charging platform have non-sparking and electrically conductive flooring. All electrical equipment in this building is Class I, Group D, explosion-proof. To minimize static hazard, relative humidity is kept at about 60 percent. All tools and port-

able equipment in the building are non-sparking. Furthermore, the wheels on trucks and other mobile containers are likewise non-sparking and conductive. There is an emergency exit and an escape chute from the charging platform.

Even though other safety features engineered into the plant are designed to eliminate sparking, it was still decided to explosion-vent all such solvent-process units as the dissolver building. To do this, 1 sq. ft. of window surface was provided for every 25 cu. ft. of room or building volume. Single-strength glass, moreover, went into the glazing. This glass was scored on the exterior so that it would blow out at a low pressure and thereby prevent structural damage.

Nitrocellulose Handling

An outside hoist with an explosion-proof motor lifts the barrels of nitrocellulose to the mezzanine or charging platform. From this level the material goes directly into the dissolver through the charging nozzle. A removable funnel fitted into the nozzle prevents spills. This funnel and the fork used to dig the nitrocellulose from the barrel are made of non-sparking metal. The top of the dissolver and hence its charging nozzle are just above the floor level of the mezzanine for convenient charging.

Solvents and diluents required to dissolve the nitrocellulose are weighed in a closed and vapor-tight scale tank located on the ground floor of the dissolver building. The weighed batch is pumped into the dissolver. Here again, the connection to the dissolver is made so that the fluid discharges inside the vessel in a relatively solid stream to avoid static spray. For added safety, the solvent pump takes suction from the top of the tank.

When the nitrocellulose has been dissolved in the solvents and diluents, the solution flows by gravity into the suction of a rotary pump which delivers it to one of the storage or hold tanks on the other side of the fire partition.

Rotary pumps in this solution storage tank room send the nitrocellulose solution from the storage tanks through a pipeline to a weighing station in the pigment grinding building about 50 ft. east of the dissolver building.

Each pump handling nitrocellulose solution is fitted with a small power-driven lubricator pump. It injects a plasticizer into the stuffing box of the pump. This prevents formation of a hard nitrocellulose film. Heat generated by friction might decompose such a nitrocellulose film. To the head of each of the three pumps a relief valve is fitted. In case a predetermined pressure is exceeded the relief valve discharges into the pump suction.

Pigments and drums of solvent are stored separately in two buildings of fire-resistant construction, located about 60 ft. north of the dissolver building. From these storehouses the pigments and drums of solvent are transported to the buildings where they are used by mechanical equipment over paved concrete walkways.

All pigment mixing and grinding operations are carried out in the pigment grinding building, another fire-resistant structure. It has all the safety features that other solvent-process units like the dissolver building have.

Mechanical equipment traveling on a roofed concrete walkway delivers containers of finished pigment paste to the coating, drying and embossing building which houses several coating and drying units. Of fire-resistant construction, this building is explosion-vented. Windows are of single-strength glass diamond-scored. The ovens or dryers are likewise explosion-vented by doors in their sides. Catches hold the doors closed. For every 25 cu. ft. of dryer space there is 1 sq. ft. of door surface. Floors are non-sparking and conductive. Carbon brushes rubbing on the shafts thoroughly ground rolls of dryers. The pigtail of each of these carbon brushes is, in turn, connected to a low-resistance ground.

While not as essential in such less critical zones as it is in the solvent-process units, explosion-proof electrical equipment, nevertheless, is used in the coating, drying and embossing building. For flammable mixtures of vapor and air can and do exist at certain locations there. It was decided, therefore, to use explosion-proof equipment throughout this structure.

To guard against formation of a mixture of flammable vapor and air in the dryers, automatic analysis of the vapor is carried on continuously. The analyzing equipment is adjusted to sound an alarm, if the vapor concentration reaches 40 percent of the lower explosive limit.

Situated 50 ft. north of the pigment grinding building is the laboratory, another fire-resistant building. Covered passageways connect the laboratory with the pigment grinding building and the embossing building. A partition separates the locker room from the laboratory. Lockers for all employees, as well as wash-up and sanitary facilities, are provided in the locker room.

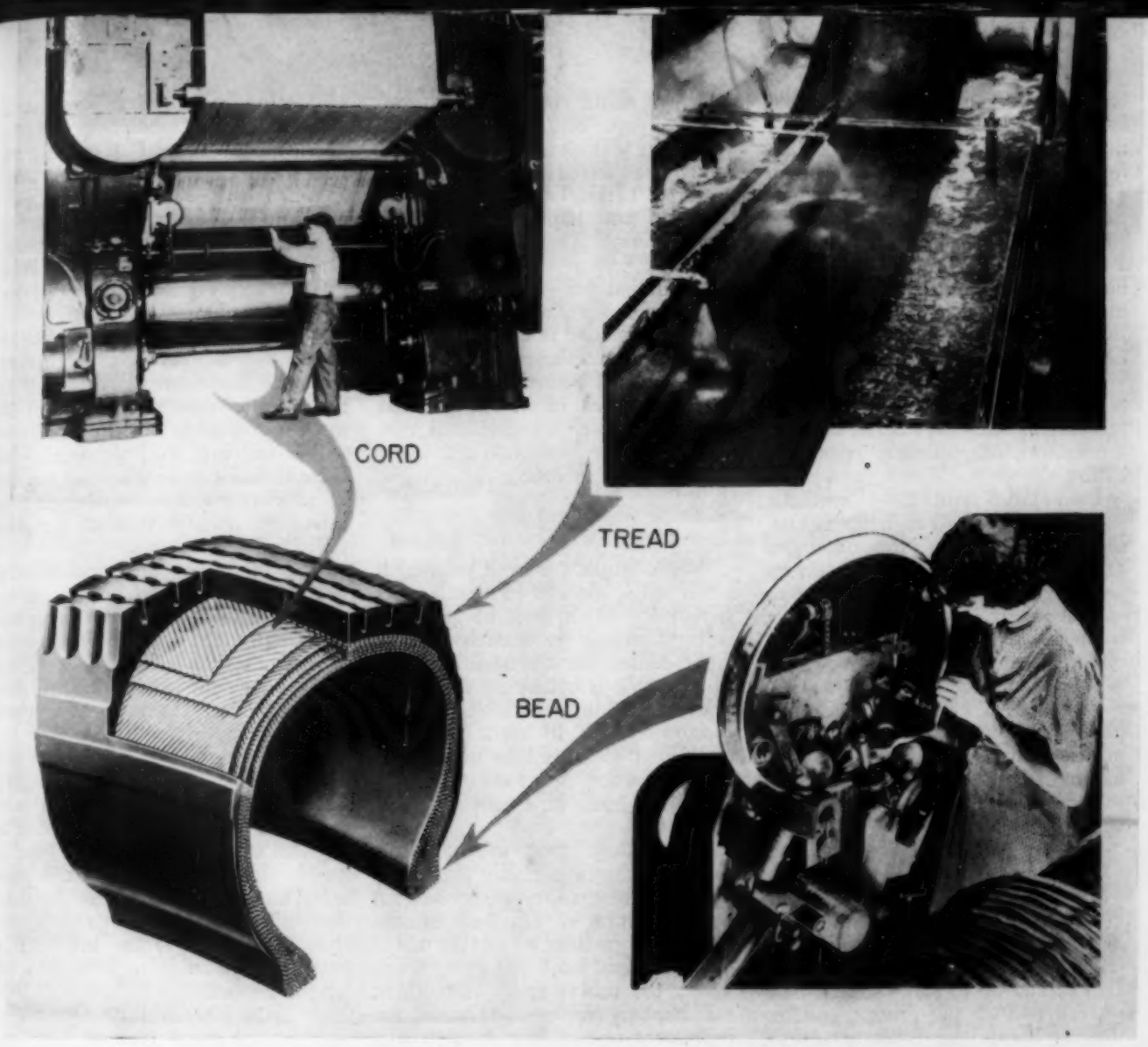
Exits from buildings got particular attention when this plant was designed. The exits have been placed so that a person does not have to travel far to reach a door. Furthermore, all doors open outward. They are equipped with panic hardware, and they are marked in the larger buildings by illuminated exit signs. At every exit of each building a safety switch is provided to cut off the current in the entire plant in an emergency.

A complete fire-fighting installation has been added to the other safeguards. The coaters and the zones around them in the embossing building can be flooded with CO_2. The dissolver in the dissolver building also can be flooded with CO_2. A sealed-head, wet-type sprinkler system protects the embossing building. The pigment grinding building and the laboratory and locker room are similarly protected. Dry-pipe sprinkler systems safeguard the solvent drum storage buildings. Open-head, deluge sprinkler systems protect the dissolver and nitrocellulose storage buildings. Hydrants, each with 200 ft. of 2½-in. canvas rubber-lined fire hose, are installed conveniently throughout the plant. An 8-in. underground fire main with water at high enough pressure and in sufficient volume supplies the hydrants and sprinklers. Besides yard protection and the sprinkler systems, all buildings are furnished with many CO_2 extinguishers of the right size for first-hand fire fighting. Showers and fire blankets are ready in all operating units for use in case anyone's clothing catches on fire.

Maximum of Safety

Its engineers have designed and put in operation for the American Finishing Co. the safest coating plant they could devise. Into it they have put a maximum of safety features to protect the property itself and the lives of employees. The management believes that its investment in safety will pay dividends in more efficient and economical production through uninterrupted service and improved product quality. With its new plant completed, American Finishing Co. now has at Memphis, Tenn., facilities to offer complete finishing services.

But now that it has had the safest equipment installed in its new plant the management does not call its job done. Through its training program employees learn the hazards of working with nitrocellulose and flammable solvents. They learn the why and how of safety regulations. And they learn a healthy respect for those regulations. For when you work with nitrocellulose there is only one place for safety—first.



IN ALL THREE OF ITS ELEMENTS—cord, tread and bead—a modern tire is a product of chemical engineering. Here we see coating of the cord, cooling of the tread stock and forming of the bead. A flowsheet is shown on pages 146-149.

Modern Methods Make 1948 Tires

JAMES A. LEE

Managing Editor, *Chemical Engineering*

MANUFACTURE OF rubber products has made progress in recent years. The new compounding ingredients have brought about almost all of the changes of a chemical engineering nature in production methods. Many of the advancements in the technique of making rubber products can be attributed to lessons learned in the handling of synthetic rubber compounds.

During the latter years of the recent war several automobile tire manufacturing plants were built in this country. The plant at Tuscaloosa, Ala., operated by the B. F. Goodrich Co., is one of the most modern of these facilities. Operations are on a single floor wherever possible and designed for straight-line flow of materials through the plant.

Manufacture of passenger car tires is divided into four steps: (1) Combining of the various ingredients such as carbon black, sulphur, zinc oxide and accelerators, with rubber, either synthetic or natural. The further processing of this mixed rubber material to provide either thin sheets, or shaped slabs, of solid material or coated fabrics which are either square woven or

of the cord type. (2) The practical assembly and cutting to shape of the necessary parts and arranging them for assembly on specialized machines. (3) The assembly of the various parts into the finished, uncured tire. (4) Forming of the assembly from a cylindrical shape to the normal tire doughnut, and the curing of the tire in steam heated molds so that the tire becomes the familiar standard finished product.

Principal compounding ingredients are natural and synthetic rubber, latex, carbon black, zinc oxide, sulphur, accelerators, oils, solvents, rayon and cotton.

Both GR-S and GR-I synthetic rubbers are used. The latter is consumed principally in inner tubes due to the fact that it tends to retain air pressure about ten times as long as natural rubber. Crude natural rubber is in the form of several grades of smoked sheet from hevea trees both in Malaya and the East Indies.

Rubber is received either in paper packages from American synthetic plants, or in bales or boxes from plantations or jungles. The rubber is stored in a warehouse at the receiving end of the great plant.

Blacks Used

Channel black arrives at the plant in tank cars in pelletized form and is unloaded onto a screw conveyor below. It is carried up to two 3-section bins, on the roof of the process building directly above the Banbury mixers. A system of electrically operated valves permits accurately weighed amounts of the carbon black to flow by gravity into Banbury batches.

Channel black is the black consumed in largest volume since its principal use is in the tire treads which make up the bulk of rubber produced. Several types of black are used in order to obtain desired physical characteristics in the various compounds required. Furnace blacks find their principal use in carcas and tube.

These softer carbons are received at the plant in paper bags. Since their properties do not allow them to be handled in a screw conveyor system they are stored in the pigment warehouse, which is part of the same section of the building that houses the Banbury mixers for purposes of good housekeeping.

Large-volume softening oils are received in tank-car quantity and pumped to heated storage tanks on the roof from which they can be fed by gravity flow into Banbury mixers below. Oils used in lesser volume are delivered in 50-gal. drums.

Dry pigments, and the like, are received in paper bags and stored in the warehouse. Petroleum solvents for cements are stored in underground 1,500-gal. tanks. Latex is received in tank cars and transferred to underground storage so as to prevent coagulation.

Preparation of the large-volume tackifying cement, used between plys of rubber, is done in an enclosed and fire-protected room, in 250-gal. jacketed churns. Finished batches of cement are stored in an 800-gal. tank from which they are circulated continuously to the production unit where the cement is used.

Process

When natural rubber is received it is too tough and stiff to absorb other ingredients which must be added in order to change its characteristics to those desired for tire manufacturing. Therefore, it is cut by an electrically heated knife into workable units of approximately 30 lb. each. These are transferred on skids into large warming ovens where they remain for a period of 24 hours at a temperature of 200 deg. F.

Immediately upon removal from the ovens the rubber slabs are fed by a roll and belt conveyor into a steam heated plasticator. This large sausage grinder-like machine softens the rubber by mechanical work and heat, which makes the rubber easier to work in the Banbury mixer and means improvement of handling characteristics of the in-process stock.

Hot rubber extruded from the plasticator is carried by a chain conveyor up an incline, through a soapstone bath, and under a cutter. Workmen remove the sheets of rubber and place them on an overhead hook conveyor which travels slowly. During the 1½ hours the slabs are on this conveyor, they dry and cool. They are removed, placed on skids and taken to the Banbury mixer.

The Banbury is used for mixing with the rubber such ingredients as carbon black, zinc oxide and oils. A typical batch is 500 lb. of accurately weighed materials. Channel black flows by gravity to the mixer from the bulk storage tanks on the roof. An enclosed automatic weighing hopper allows accurately weighed quantities of channel black to enter the mixer without handling. Paper bags of other blacks are opened by a workman under a hood in the top of the Banbury. The collecting system removes the dust.

Oils flow by gravity from heated tanks, also on the roof, and are measured by a funnel-shaped container and kept warm in a heated vessel until blown into the Banbury. Special oils, which are used in small volume, are kept warm in jacketed kettles nearby.

When the batch is thoroughly mixed it is discharged and conveyed to a cooling roll mill, and then onto a series of roll mixing mills. Here sulphur and organic accelerators are added.

Admixture of the various other ingredients with rubber is controlled to exact formulations designed to modify the rubber composition to meet requirements of the special uses within the tire. A large number of these formulations are normally in use at all times, as the requirements of each major portion of the tire are quite different.

The mixed, uncured rubber composition is sheeted out, cut to conventional size, and passed through a soapstone bath. On a hook conveyor the rubber dries and cools. Sheets are stacked on skids and retained in storage until tests indicate they meet specifications.

The stock splits at this point, part of the stock must now be partially processed by extrusion through tubing machines to give slab or strip forms to the uncured stock for later use in making treads. The other part is processed on calenders which roll the stock into ribbons or sheets of closely controlled thickness. These will later be cut to shape so as to fit within the assembled tire.

Fabrics Treated

Square woven fabrics are also treated with the rubber composition through a 3-roll calender which either applies thin sheets of rubber on top of the fabric (coating) or rubs the rubber composition into the voids between the fiber of the fabric (frictioning). These treated fabrics are then cut to shape or placed in rolls so that they may be used for bead flippers, finishing strips, etc., in the assembly of the tire.

Rubber prepared on the Banbury and mixing mill for tread stock is taken from storage and thoroughly warmed up on a series of three mills. It is then extruded through a die to proper profile and dimensions for the tire tread. Tread slabs pass through three cooling tanks before they are ready to be cut, assuring uniform shrinkage. Tire treads are cut to length, weighed and gaged to assure proper quantity and distribution of tread rubber on the completed tire. Treads are then stored on pan trucks until used on the tire building machines.

The major portion of the body, or carcass, of the tire is made of cotton, rayon or nylon cord which is received as cones or spools of individual cords. These are placed in a large rack, called a "creel," in sufficient number that the combined single cords, when laid together to form a flat sheet, will give a width of approximately 60 in. By this method the tension placed on the cords, as they pass through the coating process, can be individually controlled by devices on the creel. The sheet of weftless cords is passed through a latex dip to impregnate the cords with rubber and then dried by passing through an oven and over a series of steam heated drums resembling the drying rolls of a paper machine.

Dried cords are then passed through a special 4-roll calender which coats both sides of the cords simultaneously with the rubber composition. The rubber coated cords come from the calender as a single sheet of fabric which has no cross threads, the cords running longitudinally with the sheet.

The rubber coated layer of weftless cords is known as "ply stock." Thickness of the sheet is indicated by variable condensers. The sheet is rolled into a liner to keep the stock from sticking to itself and placed in temporary storage. It is next unrolled and cut on the bias, to widths of such size as to equal the expanded width of the individual tire, for use as tire plies.

The tire is held to the rim of the car by means of a wire ring which is built into the tire. The ring and the fabric covers of rubber composition which surrounds it is called the tire "bead." Wire for the manufacture of the bead is received on spools and is formed to the ring shape by running multiple strands through a coating machine. This covers the strands with a special rubber composition and then winds the wire upon itself on a form to the proper diameter. This formed ring is covered with fabric cut from rolls which have been frictioned in the calender, as mentioned above.

Tire Building

At the tire building machines, beads, treads, and other parts are assembled to produce a green or unvulcanized tire. Components are placed in special feeding devices which are so arranged that mechanical accuracy is stressed in making the tire assembly. The tire is assembled by placing the cord fabric which has been cut into blocks, as above, on a steel collapsible drum mounted on the building machine. In assembling four-ply tires, two plies of the cord fabric are normally placed on the drum so that the cords of the alternate layers are at right angles to each other. The beads are then placed in position and attached to the plies by turning the outside edges of the plies over the bead. Two more alternating plies are then placed on the drum and locked around the bead by turning the outer edges of the plies down and around the bead.

In order to protect the tire from bruises, partial plies (breaker strips or inserts) are then applied on top of the last ply at such a position that they will be under the tread portion of the tire after the tire has been completed. To protect the beads against the chafing action of the metal rim, strips of fabric are applied on the drum so that they will cover the outside of the bead after the tire has been completed. The tread portion of the tire which includes the rubber cover for the sides, as well as the portion which will run on the road, is then applied to the drum. The drum is collapsed and the tire, which is now a clyinder without ends, is removed. This cylinder is placed in a forming machine and a special shaping tube called a curing bag (similar in appearance to the standard inner tube but much thicker and stiffer) is placed inside the cylinder. By mechanical pressure from the machine and air pressure within the bag the tire is formed to the familiar doughnut shape. The forming bag remains inside the tire and at this stage there is no tread design.

Vulcanization

Vulcanization of tires is accomplished in molds which are heated in steam dome type presses. Steam pressure in the dome is maintained to produce a vulcanization temperature of about 300 deg. F. High pressure steam within the curing bag expands the tire against the mold which has the tread design cut into its surface. Due to the heat from the mold and from the steam within the bag, the tire is first softened, the rubber flowing up into the mold, and as heating continues, the action of cure progresses and the rubber is changed from a soft, plastic condition to the hard, somewhat horny material of the finished product. After the prescribed period of cure, which is very carefully regulated by automatic timers and controls, the tire is removed from the mold. A 6.00-16 size tire is completely vulcanized in about three quarters of an hour. Larger size tires require correspondingly longer vulcanization cycle.

A special bag stripping machine accomplishes removal of the curing bag from the tire after vulcanization is complete. The curing bag is then recycled. As soon as bags are removed tires are painted, carefully inspected for defects and balanced. Any tire which is outside of the tolerance range for balance must be treated with a special balance paint on the inside of the tire so as to bring it within tolerance, before it can be sent to the warehouse as a first class tire.

Inner Tubes

The inner tube master batch of rubber prepared in a Banbury mixer is made into sheet form on a mill. The sheet is rolled into pigs to retain the heat. The pigs of unvulcanized rubber composition are warmed on a mill and carried on a strip feed overhead belt conveyor to a 30-mesh wire strainer. This removes any foreign matter which might cause a leaky inner tube. The final mixing mill, equipped with an overhead mixer, is used to finish up inner tube batches by addition of proper amounts of sulphur and accelerators. The rubber then goes on an overhead belt conveyor to a tubing machine for extrusion to proper dimension for the various sizes of tubes.

Soapstone is dusted onto the inside of the tube of rubber as it is formed. The extruded tube is picked up by a moving belt conveyor and carried under a marking machine for indicating the type rubber used. The tube next receives a patch to keep a small area of the surface clean for valve application later. The tube is removed from the belt and passes through a trough of water and under a water spray, then it passes through a soapstone solution which serves as a lubricant. Another belt carries it under a knife which cuts the tube into proper lengths after which it is transferred to pan trucks.

After aging in pan trucks for four hours, or more, the patches are removed and valves are applied. The splicing of the tube ends and the pressing of the splice complete the preparation of the tube for vulcanization.

Inner tubes are formed on a forming ring and then vulcanized in steam jacketed molds. Internal steam pressure there forces the tube against the hot mold to effect the vulcanization. After vulcanization tubes are hung on overhead conveyors for cooling and delivery to the final inspection unit at the far end of the building.

An electrical balancing device determines amount the tube is out of balance. After all air is removed a small volume is replaced before packaging. This air prevents sharp folds in the rubber tube. Tubes are either sent to storage for shipment or inserted in tires for shipment.

THE PLANT NOTEBOOK

Theodore R. Olive, ASSOCIATE EDITOR

March Contest Prize Winner

SLIDE RULE FOR RAPID COMPUTATION OF VOLUMES OF CYLINDRICAL, CONICAL AND RECTANGULAR TANKS

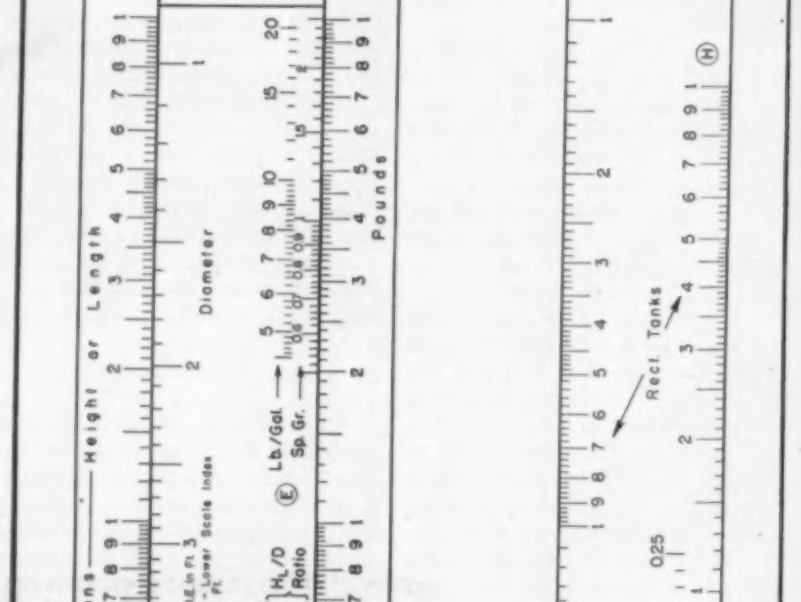
ALFRED B. BABCOCK, JR.
Chemical Engineer
Casein Co. of America Div. of The Borden Co.
Greensboro, N. C.

WHEN need arose for a simple and rapid method for determining volumes and weights of solutions stored in various shaped tanks, a homemade slide rule was developed for situations most normally encountered.

The rule can determine the volume and weight of solution stored any depth in vertical cylindrical tanks, horizontal cylindrical tanks, and conical tanks. If desired, the volumes of rectangular tanks and partly filled dished ends may also be obtained from additional scales on the back of the slide. All scales are ordinary logarithmics except those which determine the volumes of partly filled horizontal cylindrical tanks and dished ends.

As can be seen from the drawing, Scales *A*, *D*, *E*, and *H* are two-cycle logarithmics, Scale *B* is a reversed single cycle, and Scale *F* is a reversed two-cycle. Scales *C* and *G* are empirically determined. If height (or length) and total volume are designated by Scale *A* and diameter by Scale *B*, then by coinciding the height with the diameter, the volume of cylindrical or conical tanks is found on Scale *A* above the proper index. Conversion factors are incorporated by the proper location of the index. Four indices are shown to permit computation of cylindrical tank volumes using either inches or feet in any combination. Using the index of "*H* & *D* in Ft." any total volume in gallons from Scale *A* may be converted to pounds by using Scale *E* if either specific gravity or pounds per gallon is known.

For partly filled horizontal tanks reference was made to Perry's "Chemical Engineers' Handbook" (McGraw-Hill, 2nd Ed., 1941, pages 119-122). The ratio of liquid depth to tank diameter is proportional to the ratio of the liquid volume to the tank volume. Therefore, if a scale is made to



Scales for slide rule for volumes of cylindrical, conical and rectangular tanks.

APRIL WINNER

A $50 prize will be issued to

A. FARKAS

The Barrett Division
Allied Chemical & Dye Corp.
Philadelphia, Pa.

For an article offering a simple method of applying photoelectric control to a colorless liquid in a gage glass which has been judged the winner of our April contest.

This article will appear in our June issue. Watch for it!

designate the depth ratio, the partial volume can be read on Scale *D*. The index of "*H* & *D* in Ft." on Scale *B* is set opposite the total volume on Scale *A*, and the partly filled volume is found on Scale *D* opposite the depth ratio on Scale *C*.

Scale *C* can be made from the drawing, or from the ratios in the accompanying tabulation, which is made from the table on horizontal tank volumes on pages 120 and 121 of Perry. The ratios must, of course, be expressed logarithmically on Scale *C*. If more divisions are desired, they may be made accurately enough for all practical purposes by logarithmic interval division of each section.

Calculation of the volume of partly filled standard dished ends (radius of curvature equal to three times tank radius) may also be found from Scale *G* if a new index is added to Scales *B* and *F* to indicate the total volume of two ends. The volume is found by coinciding the tank diameter in feet on Scale *A* with tank diameter on Scale *B*, and reading the total volume of the dished ends on Scale A opposite index "*D.E.* in Ft.". The partial volume is found in the same way as for horizontal tanks, using Scale *G*. The position of the index and Scale *G* markings were determined from the formula: $V = 9.33 \times 10^{-4}h^2(3r-h)$ as given in Perry, page 122, where *V* is the volume of the liquid in two ends, *h* is the liquid height, and *r* is the radius of the tank, with *r* and *h* in inches. (Doolittle formula, *Ind. Eng. Chem.*, March 1928.)

Rectangular Tanks

For rectangular tank volumes, a reversed two-cycle Scale *F* can be added to the back of the slide at the top, and a one-half two-cycle scale to the bottom at *H*. The lower scale should be located on the slide so that by coinciding two tank dimensions on the top scales, total volume in gallons will appear on Scale *D* opposite the third tank dimension on Scale *H*.

The rule parts may be made of stiff white cardboard or plastic. A "modulus" chart (Perry, *ibid.*, page 257) or a proportional interval divider (Bennett, *Chem. Eng.*, p. 138, Dec. 1947) is helpful in laying out the logarithmic scales. A photographic copy of a slide rule can also be used for the ordinary scales when glued to an old slide rule.

Volume Ratios in Party Filled Horizontal Tanks for Various Depth Ratios

H_L/D	V_L/V	H_L/D	V_L/V
0.05	0.019	0.55	0.564
0.10	0.052	0.60	0.626
0.15	0.094	0.65	0.688
0.20	0.142	0.70	0.748
0.25	0.196	0.75	0.805
0.30	0.252	0.80	0.858
0.35	0.312	0.85	0.906
0.40	0.374	0.90	0.948
0.45	0.436	0.95	0.981
0.50	0.500	1.00	1.000

$50 CASH PRIZE FOR A GOOD IDEA!

Until further notice the editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. The winner each month will be announced in the issue of the next month: e.g., the May winner will be announced in June and his article published in July. Judges will be the editors of *Chemical Engineering*. Non-winning articles submitted for this contest will be published if acceptable at our usual space rates.

Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 300 words, but illustrated if possible. Articles may deal with any sort of plant or production "kink' or shortcut that will be of interest to chemical engineers in the process industries. In addition novel means of presenting useful data, as well as new cost-cutting ideas, are acceptable. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 18, N. Y.

SIMPLIFIED METHOD OF FIGURING ROTARY DRYER PERFORMANCE

J. F. SCHNACKY
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A METHOD is here described for correlating the physical processes of the drying operation in a rotary dryer with the actual dryer length and heat transfer rates.

For nominal temperature differences below 150 deg. F., an over-all heat transfer coefficient of 10 Btu. per hour, sq. ft. and deg. F. is fairly consistent for heat transfer from condensing jacket steam to granular material flowing in the neighborhood of 1 ft. per min., in cases where the dryer is approximately 30 in. in diameter and the material occupies about two-thirds of the cross section. A preliminary temperature-moisture content run (Fig. 1) will determine at what temperatures various portions of the volatile material is removed. Then, considering the individual sections of dryer length *A*, *B*, *C*, *D*, *E*, and *F*, and fixing the jacket steam temperature at the saturation pressure of the available steam supply, individual log mean temperature differences may be calculated for each section.

Refer to the well known rate equation, $Q = UA\Delta T$, where *Q* for each section is calculated by a summation of sensible and latent heats for each section, *U* is 10, *A* is to be determined, and the log mean temperature difference ΔT has been determined above. Knowing the diameter of rotary dryer available further simplifies matters by enabling A to be expressed as a function of the dryer length *L*. Hence, $A = \pi DL$, where *L* is the length of the dryer in feet and diameter *D* equals 30 in. for this case. Therefore, a plot of Q/L vs. *L* (see Fig. 2) will present a physical picture of the heat load on each individual section, because the integrated area under the curve represents the total Btu. per hour required for any seg-

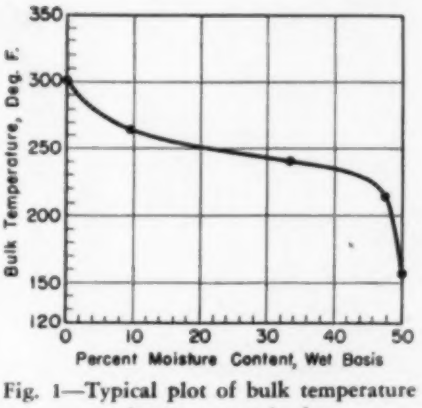


Fig. 1—Typical plot of bulk temperature vs. moisture content in dryer.

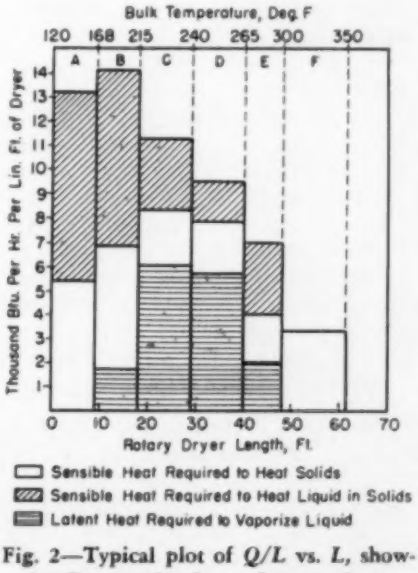

Bulk Temperature, Deg. F
120 168 215 240 265 300 350
A
B
C
D
E
F
Thousand Btu. Per Hr. Per Lin. Ft. of Dryer
0 10 20 30 40 50 60 70
Rotary Dryer Length, Ft.
Sensible Heat Required to Heat Solids
Sensible Heat Required to Heat Liquid in Solids
Latent Heat Required to Vaporize Liquid

Fig. 2—Typical plot of Q/L vs. *L*, showing Btu. per hr. for various sections.

ment length of dryer. Then, if the standard dryer length is 20 ft., by merely drawing a vertical line through the graph at $L = 20$, the integrated section to the left of the line will represent the Btu. per hour required for the first dryer.

In turn, this quantity plus the radiation effects will determine the quantity of steam required for the first dryer. Another excellent feature of Fig. 2 is that when the sensible heat load is delineated from the latent heat load, one can very readily determine the size of vapor pipes required and their necessary spacing along the lineal length of the dryer to assure low vapor velocities at all points and minimize dusting problems. Naturally, this assumes a homogeneous vapor is being dried from the solid, the latent heat of vaporization and specific volume of such vapor being known.

This operation can be repeated for the next dryer length, and so on, until the complete drying cycle is portrayed. Then, if an odd length of dryer is required at the end, we may expand this to the full standard length and lower the steam pressure to be used on the jacket, to allow for a certain percentage of dryer overcapacity.

Thus it may be seen that a complicated drying operation may be simply represented by Fig. 2, showing the variable heat load with dryer length, and depicting the actual quantities of vapor to be removed by the latent heat in various sections.

NOMOGRAM FOR VAPOR PRESSURES OF BINARY SOLUTIONS

MACK TYNER
Chemical Engineering Department
University of Florida, Gainesville, Fla.

EXPERIMENTAL data on the partial pressure and total pressures of binary systems as they are affected by composition and temperature are generally given in tabular form. In such form it is frequently necessary to interpolate in the table for both the temperature and composition in question. This extra work can be avoided by presenting the data in the form of a vapor pressure nomogram. This paper shows the need for such a pressure-temperature-composition correlation and how to construct a suitable chart for binary aqueous solutions.

The integrated Clausius-Clapeyron equation is a widely used means of correlating vapor pressures. This integrated equation assumes (1) that the vapor is a perfect gas, (2) that the latent heat of evaporation is constant, and (3) that the volume of the liquid is negligible, in comparison to the volume of vapor. These approximations result in the equation:

$$\log p = -\frac{L}{RT} + C$$

Where p is vapor pressure, T is absolute temperature, R is the gas constant, L is latent heat and C is a constant for each substance. All variables are expressed in consistent units. This equation reproduces the vapor pressure data for many substances over a wide range with fair accuracy.

Cox[1] introduced the now familiar "Cox Chart" method of plotting vapor pressure data to obtain straight lines over wide ranges of temperatures. Calingaert and Davis[2] showed that the use of the "Cox Chart" is equivalent to using an empirical equation similar to the integrated approximate Clausius-Clapeyron equation except that the empirical value of 230 is chosen for the ice point of the Kelvin temperature scale. Thus, vapor pressure data plotted on the log P vs. reciprocal (t deg. C. + 230) chart result in straight lines for those substances which give straight lines on a "Cox Chart."

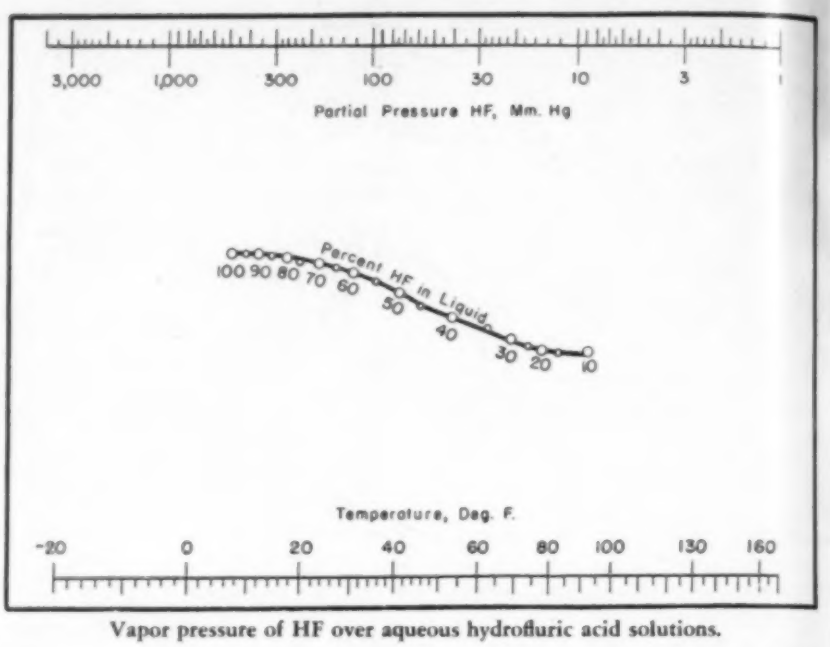
Guggenheim[3] and Othmer[4,7] have shown that the partial pressures as well as total pressures in binary systems follow the general relationship expressed by the equation above. Othmer prefers the reference substance plot (Cox Chart) over the reciprocal temperature plot. In either case the partial pressure or total pressure on a binary system is easily correlated with the temperature by the equation given, or by a reference substance plot. This type of correlation is not as common in the engineering literature as it should be and it is the purpose of this paper to draw attention to the usefulness of nomograms based on the above principles in presenting partial pressure data on binary solutions.

For purpose of illustrating the application of this principle, the system HF-H_2O was chosen. Data on the partial pressure of hydrogen fluoride over its aqueous solutions are available.[5,6] The accompanying chart is made by constructing logarithmic pressure and reciprocal (t deg. C. + 230) temperature scales on parallel lines and then plotting the liquid composition curve from the experimental data given in Ref. (5) and (6). A check on the accuracy of the nomogram can be made by comparing nomogram readings with the data from which it was constructed. It is expected that the nomograms will be least reliable at temperature extremes, i.e., below 0 deg. C. and above 100 deg. C. The tabulation shows a comparison of data from Ref. (5) with the nomogram.

Thus it is seen that the nomogram reproduces the experimental data with sufficient accuracy for slide rule engineering calculations.

Comparison of Nomogram With Data
Pressure in mm. Hg

Percent HF, Wt.	0 Deg. C. Ref. (5)	0 Deg. C. Nomogram	100 Deg. C. Ref. (5)	100 Deg. C. Nomogram
10	———	———	12.5	12.5
40	1.95	1.90	275.	270.
50	9.0	8.6	620.	600.
100	350.	350.	.....	....



Vapor pressure of HF over aqueous hydrofluric acid solutions.

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1. Cox, E. R., *Ind. Eng. Chem.*, 15, 592 (1923).
2. Calingaert and Davis, *Ind. Eng. Chem.*, 17, 1287-89 (1925).
3. Guggenheim, E. A., "Modern Thermodynamics," Methuen and Co. Ltd., London (1933).
4. Othmer and Gilmont, *Ind. Eng. Chem.*, 36, 858-65, (1944).
5. Technical Bulletin No. 30 A, General Chemical Co., New York 6, N. Y.
6. Brosheer, Lenfesty and Elmore, *Ind. Eng. Chem.*, 39, 423-27 (1947).
7. Othmer, D. F., *Chem. Met. Eng.*, 47, 296 (1940).

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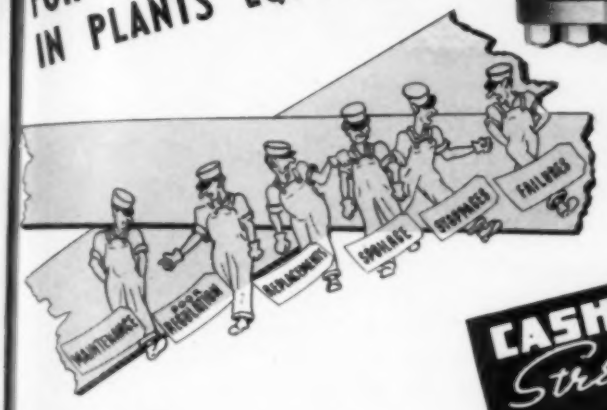
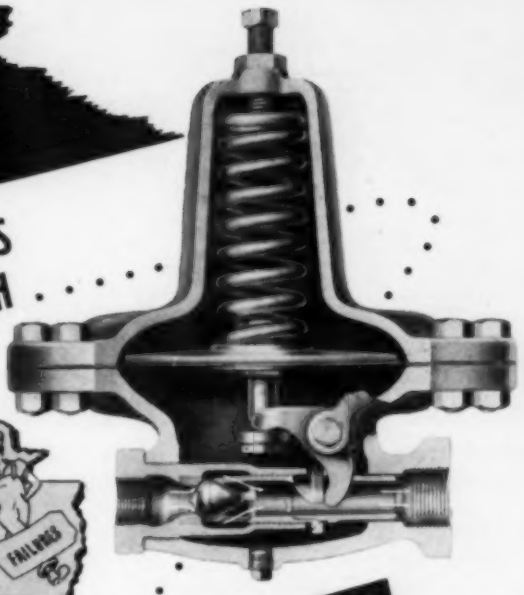
FOR THESE TROUBLEMAKERS IN PLANTS EQUIPPED WITH . . . . .





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Here's why

IN THE USERS OWN WORDS . . . . .

(Note how users' statements check against the 10 benefit points listed below)

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"We installed your '1000' reducing valve in our re-capping set-up about six years ago and to this date we have had **trouble-free** service. Periodically I check steam **pressure** and find it to be very **accurate.** I wouldn't hesitate a minute in recommending your Streamlined Reducing Valve."

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We use the type '1000' valves on one of the **toughest operations** and they have operated 24 hours per day for the past 2½ years with **no maintenance."**

FROM A GLASS MANUFACTURER

"We have one set of five pressure reducing valves (CASH STANDARD '1000') on a Hartford Empire ZU forehearth that have **operated accurately** and **trouble free** for five years **without** a dimes worth of **maintenance."**

FROM A LAUNDRY

"We are well satisfied. We get **accurate pressure control under toughest working conditions — trouble-free service — cost-saving operation and practically zero in maintenance costs."**

FROM A CHEMICAL MANUFACTURER

"We purchased our first CASH STANDARD Type '1000' Streamlined Valve six years ago and since then we have installed more than 200 of the '1000' valves ranging in size from ¼" to 1½". This is indicative of our complete satisfaction with the operation of the '1000'. A large number of the pressure reducing valves are **operating above your maximum specifications of temperature and pressure** with excellent results.

"The **elimination** of **steam leaks** and the **low maintenance** cost have been especially gratifying. The low initial cost, **low maintenance,** and **trouble-free** operation results in the **most economical** pressure reducing valve we have been able to purchase."

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2. **Accurate pressure control under toughest working conditions.**
3. **Trouble-free service.**
4. **Smooth operation.**
5. **Tight closure.**
6. **Speedier production results.**
7. **Elimination of failures.**
8. **Cost-saving operation.**
9. **No spoilage.**
10. **Practically zero in maintenance.**

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CASH STANDARD CONTROLS . . . VALVES

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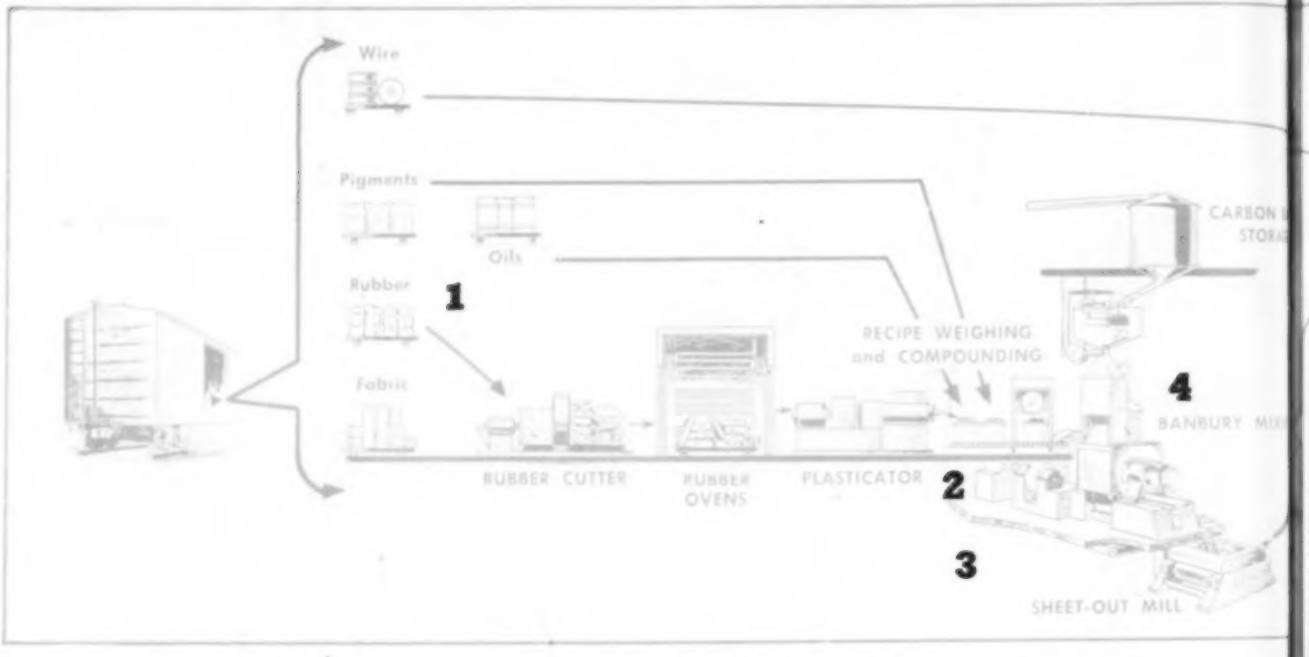
PICTURED FLOWSHEET

This automobile tire and inner tube plant of The B. F. Goodrich Co. at Tuscaloosa, Ala., is one of the most modern in the United States. Operations were designed for straight-line flow.



Rubber Tire Production

At Tuscaloosa, Ala., is a plant of the B. F. Goodrich Co. It is one of the most modern rubber tire and inner tube plants in this country. Production takes place on a single floor and is designed for straight line flow of materials and operations.

Rubber is received at one end of the building, stored and as required warmed in large ovens. Warmed rubber is softened in a plasticator from which it is extruded. It is sheeted and cooled. Pigments and oils are added to the rubber in a Banbury mixer. The compound passes to a mixing mill where vulcanizing agents and organic accelerators are added. The uncured rubber composition is cut off in slabs, cooled on overhead conveyors and stored for use in subsequent operations.

Admixture of the various other ingredients with rubber is controlled to formulations designed to modify the rubber composition to meet requirements of the special uses within the tire. A large number of these formulations are normally in use at all times, as the major requirements of each portion of the tire are quite different.

Manufacture of the tire might be considered as starting with the formation of a sheet of weftless cords from cotton or rayon cords. The sheet is passed through a latex dip to impregnate it with rubber and dried by passing through an oven and over a series of steam heated drums. Dried weftless cords pass to a four-roll calender where a coating of rubber, prepared as previously mentioned, is applied on each side. This rubber coated layer of weftless cords is known as ply stock and is subsequently cut up for use as tire plys. It is stored until ready to be cut.

Another portion of the rubber compound prepared in the Banbury and on the mills is prepared for use as treads. It is extruded, cooled and stored on pans until required for tire building.

The remainder of the steps, of which there are many, have to do with the building of the tire, vulcanization, finishing operations, inspection and shipping.

CHEMICAL ENGINEERING

May 1948

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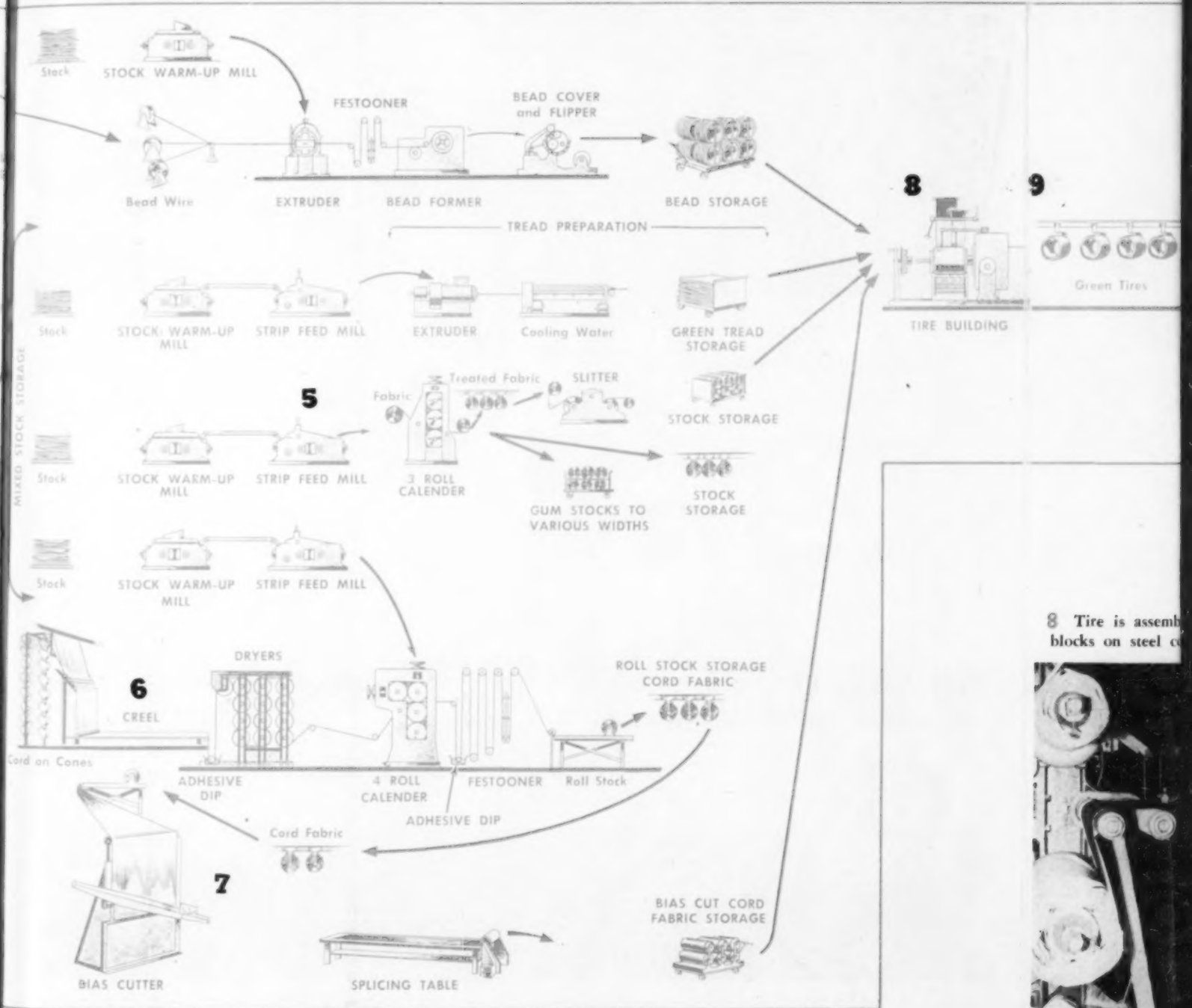
1 Rubber must be cut up, warmed and passed through plasticator which softens it by work and heat.

2 Hot rubber extruded from plasticator is carried by chain conveyor.

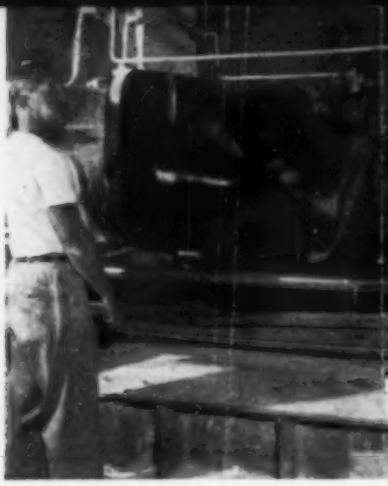
3 On leaving soapstone bath rubber is cooled on conveyor, then transferred to skids.



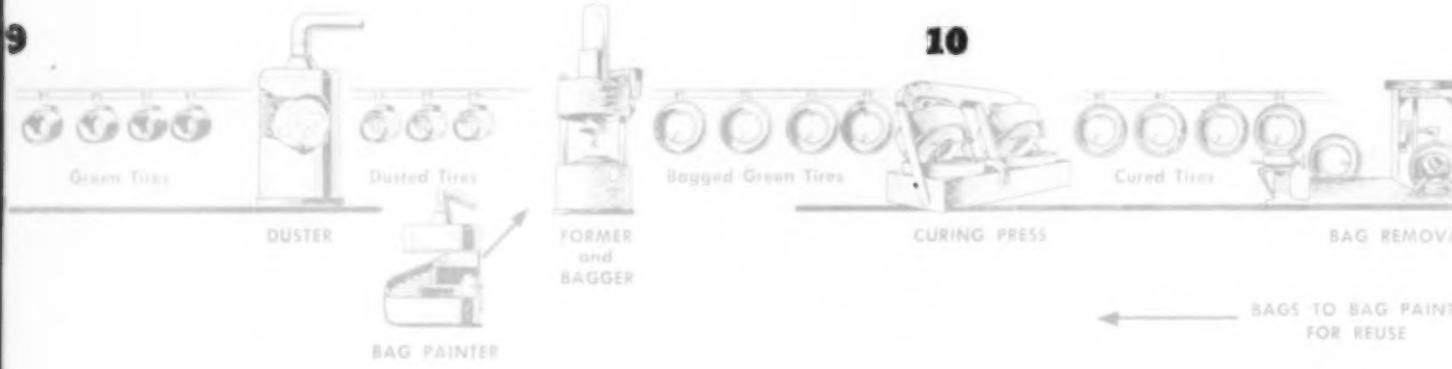
8 Tire is assemb
blocks on steel c

ath rubber is cooled and dried
ed to skids.

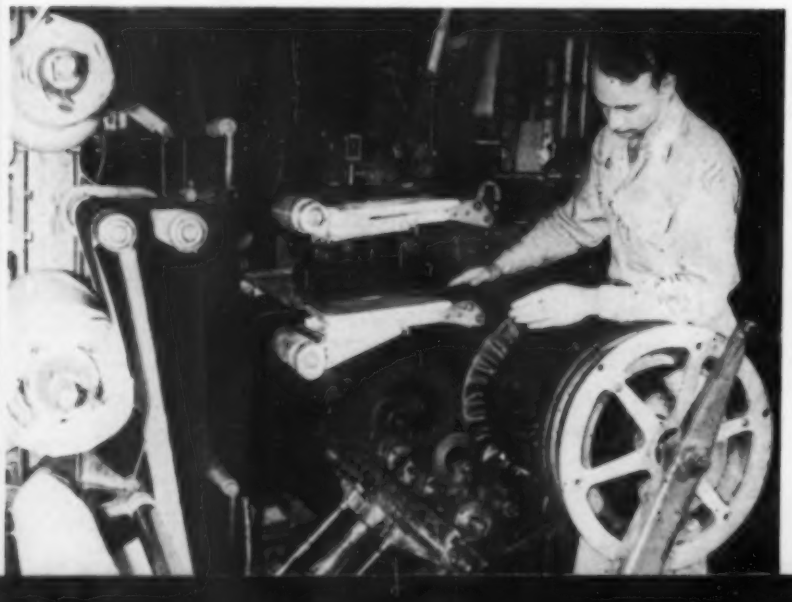
4 Rubber is mixed by Banbury with such ingredients as carbon black, zinc oxide and oils.



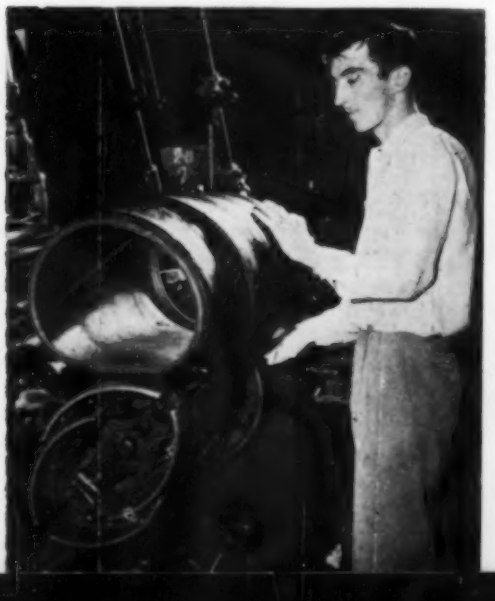
5 Rubber is warmed up on a mi
used for treating fabrics on a 3-ro



8 Tire is assembled by placing cord fabric which has been cut into blocks on steel collapsible drum mounted on building machine.

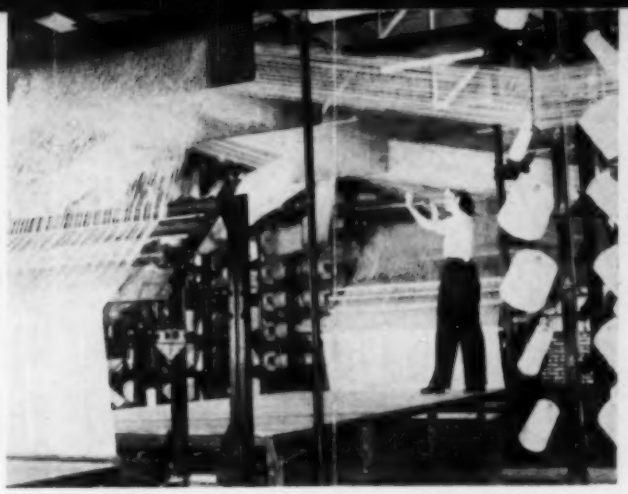


9 Drum is collapsed and tire which is now a cylinder without ends is removed.



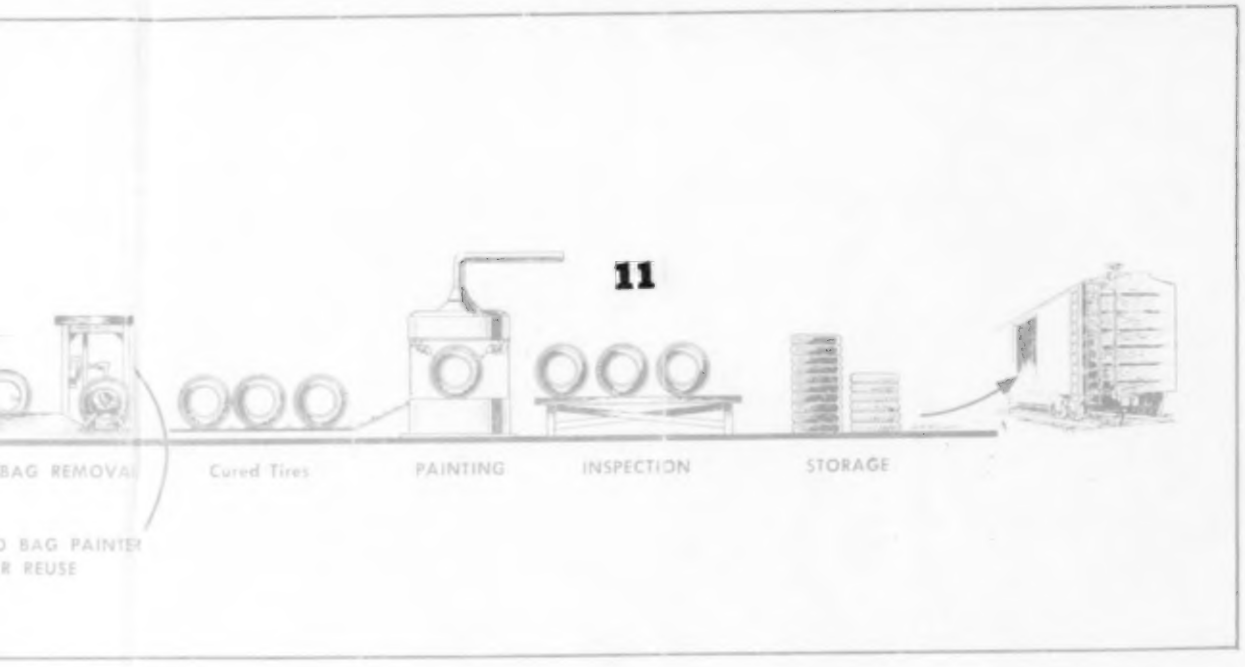
10 A
motiv

up on a mill. It will be
s on a 3-roll calendar.

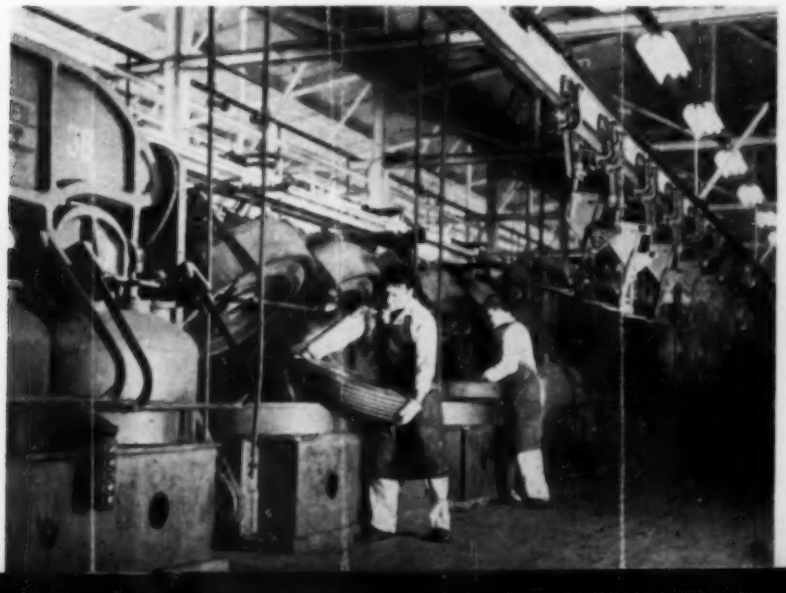


6 Cotton, rayon or nylon cords received on cones or spools are assembled into sheets of weftless cords.

7 Rubber coated layer of weftless cords, ply stock, is cut on the bias for use as tire plies.



10 After prescribed period of cure, which is carefully regulated by automotive timers and controls, tire is removed from mold.



11 After tire is revulcanized and curing bag is removed, it is painted, carefully inspected for defects and balanced.

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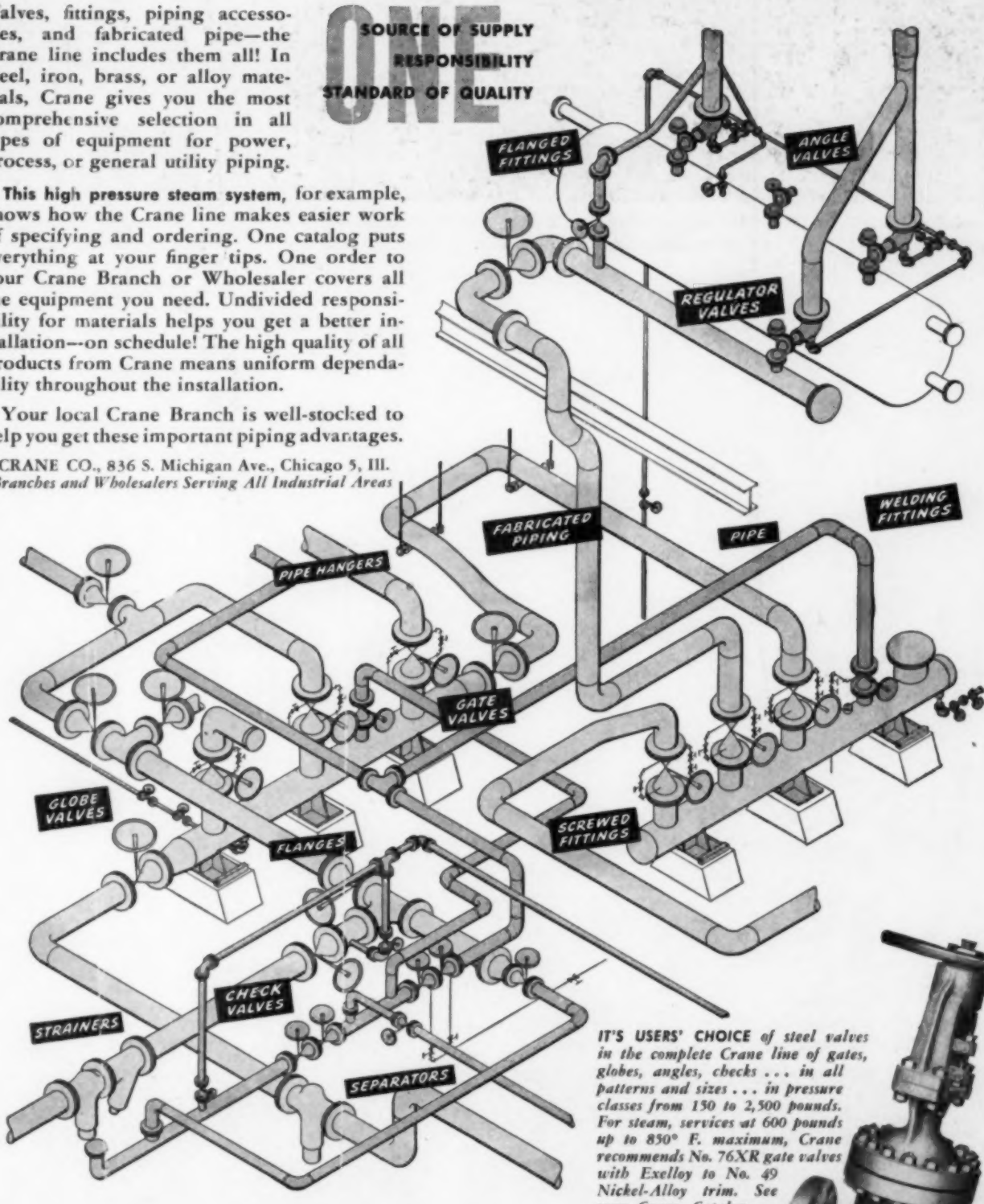

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Bulletin No. 57, available on request, gives further details.

SINCE 1887

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RAYMOND PULVERIZER DIVISION
1311 North Branch Street, Chicago 22, Illinois

PROCESS EQUIPMENT NEWS

Theodore R. Olive, ASSOCIATE EDITOR

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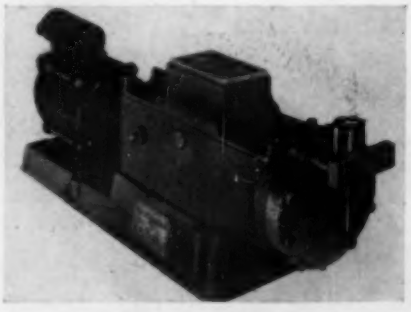
Coupon on pages 169-170

1. Oxygen Plant

AFTER several months of successful operation of its pilot plant, the Elliott Co., Jeannette, Pa., has announced a new low-pressure oxygen process which is said to operate indefinitely without periodic shut-downs for "defrosting." The process, intended for producing tonnage oxygen of 95 percent purity, required three years for its development and incorporates a number of novel features, including mechanical simplification as compared with usual tonnage oxygen processes. The process employs reversing exchangers which, however, are reversed every three or four hours, instead of every two or three minutes as in other systems.

The exchangers require only one hot and one cold gas, as contrasted to the multi-fluid exchangers generally used. All controls are automatic, and it is possible to set them so that the oxygen plant will automatically follow process demands without requiring manual attention from the operators. An over-all recovery of oxygen from air of over 97 percent is claimed, and it is stated that the nitrogen leaving the process is sufficiently pure for chemical raw material use. Although the process can produce 99.5 percent oxygen—and can produce part of its output of this purity coincident with 95 percent oxygen—it is more economical to work in the 95-97 percent range. Maximum pressure in the system is only 5 psig., and distillation takes place completely within a single column. All refrigeration is produced by compressing and then expanding the nitrogen output through a radial-flow turbo-expander.



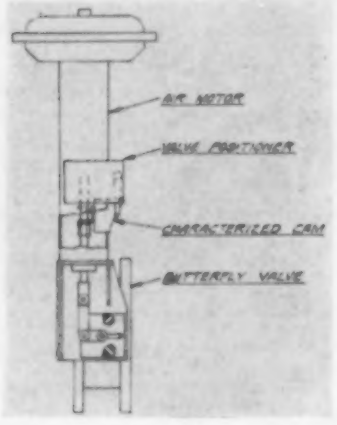
2. Proportioning Pump

COMPLETELY new design is incorporated in a new line of Pulsafeeder proportioning pumps, announced under the designation of Model CP, by Lapp Insulator Co., LeRoy, N. Y. Pumping action is accomplished by a piston reciprocating over a measured stroke which displaces oil. The oil in turn pulsates a diaphragm and the diaphragm pumps the chemical. This arrangement requires no stuffing box and presents no lubrication problem. The pump is continuously adjustable over its entire range, either while in operation or while idle. It incorporates a built-in pressure relief valve which, however, handles only oil. A feature of this design is that the diaphragm itself does no work, but serves merely as a partition between the hydraulic oil and the chemical handled.

3. Electric Flow Meter

A NEW TYPE of electric flow meter which makes use of the principle of supplying a measured amount of energy and then measuring the temperature rise resulting, has been announced by Charles Englehard, Inc., 850 Passaic Ave., East Newark, N. J. Actually, the meter varies the amount of energy supplied so as to produce a constant temperature rise. The instrument gives both flow rate and integrated flow and an important feature is that the fluid being measured does not

need to come in direct contact with the measuring elements which are arranged on the outside of the pipeline. Thus there is no possibility of leakage, contamination, corrosion or clogging up. The transmitting unit on the pipeline and the receiver can be separated by any convenient distance if remote control or metering is required, without affecting accuracy of the instrument.



4. Butterfly Control Valve

ANY DESIRED control characteristics can be incorporated in a new diaphragm motor valve of the butterfly type announced by the R-S Products Corp., Philadelphia, Pa. Characteristics comparable to those of control valves with straight-line, semi-log, ratio-plug, throttle-plug and other special characteristics are provided by the use of a cam-operated positioner. To obtain the desired characteristics, it is only necessary to employ a cam of the proper character which can be changed in the field, if desired, to change characteristics. The manufacturer points out that this arrangement permits combining the special flow characteristics of other valve types with the special advantages from a cost and capacity standpoint of the butterfly valve.

5. Hydraulic Drive Pump

PARTICULARLY suited for automatic control is the new Type K hydraulic drive pump for metering and proportioning that has been developed by Hills-McCanna Co., 3025 North Western Ave., Chicago 18, Ill. This is a two-cylinder, double-opposed plunger pump driven through a hydraulic mechanism which incorporates a full range of adjustment for the pump plungers. This adjustment is accomplished by controlling the amount of fluid contained in a hydraulic cylinder situated between the drive mechanism and the pump plunger. On the discharge stroke, accurate valving arrangements permit the escape of fluid until the proper amount remains in the cylinder. At this point the valve closes and the remaining fluid in the cylinder acts as a solid, driving the pump plunger. On the suction stroke the cylinder is automatically refilled and the cycle repeated. The pump plunger is returned to the same starting point with each stroke, regardless of stroke length. Lubricating oil serves as the hydraulic fluid and also acts as a lubricant for the driving mechanism. The pump is produced in sizes up to 300 gph. for one feed (or 600 gph. for two), for pressures as high as 25,000 psi. for a special liquid end, or 5,000 psi. for the standard liquid end.

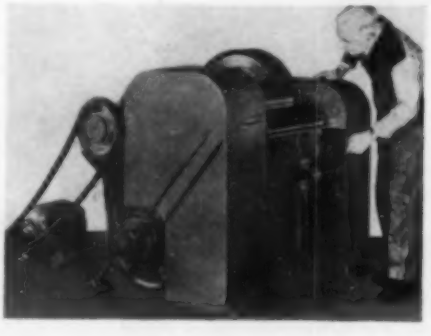
Cost Indexes for Typical Process Equipment

IN OUR issue of November 1947, pages 124-126, we presented for the first time the Marshall and Stevens indexes for comparative costs of equipment in eight typical process industries and four closely related industries, together with an average index for the 47 different industries, process and non-process, that are regularly covered in this evaluation firm's extensive studies.

R. W. Stevens, partner of this Chicago and Los Angeles firm, described the methods of obtaining the index numbers in that issue, and listed the indexes back to 1913. At intervals we plan to reprint the complete tabulation from 1913 to current date, while quarterly figures will be published henceforth in our February, May, August and November issues. The quarterly indexes will include: "Year Ago," "Last Quarter," and "This Quarter."

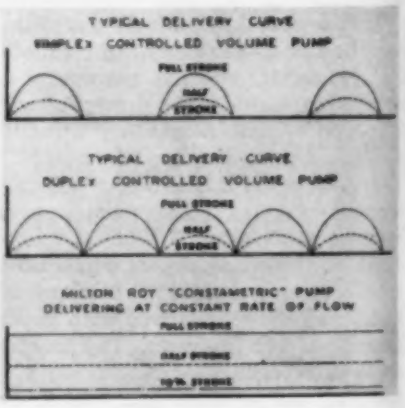
Marshall and Stevens Indexes of Comparative Equipment Costs (1926 = 100)

Industry	Mar. 1947	Dec. 1947	Mar. 1948
Average of all	147.1	155.2	158.4
Process Industries			
Cement mfg.	140.5	148.7	152.0
Chemical	147.6	156.5	160.0
Clay products	135.8	144.6	147.0
Glass mfg.	138.4	146.8	150.1
Paint mfg.	142.0	150.8	153.3
Paper mfg.	143.2	151.4	153.6
Petroleum ind.	142.9	153.0	156.4
Rubber ind.	147.4	155.4	158.8
Process ind. avg.	145.4	154.2	157.4
Related Industries			
Elec. power equip.	146.2	154.3	161.6
Mining, milling	149.2	157.2	160.7
Refrigerating	159.0	168.3	170.6
Steam power	137.8	146.4	148.7



6. Dicing Cutter

TO PRODUCE accurate, uniform pieces of plastic materials from continuous sheets, Taylor-Stiles & Co., Riegelsville, N. J., has introduced a precision dicing cutter which combines disk cutters with knives. The machine takes plastic sheets ⅛ in. thick and 15 in. wide, fed direct from the strip mill. The sheets are first disk cut into ½ in. strips, then automatically fed to knives and crosscut into ½ in. cubes at rates up to 75 lin.ft. per minute.



Volume discharge curves for simplex, duplex and the new Constametric pump.

7. Proportioning Pump

DELIVERY without pulsation at any capacity from a maximum down to as little as 75 ml. per hr. is claimed for the new Constametric proportioning pump developed by Milton Roy Co., 1322 Mermaid Ave., Philadelphia 18, Pa. Prices are now being quoted by the manufacturer, although deliveries will not be available until summer or early fall.

The constant flow is achieved by translation of the motion of the driver through cams to cause a plunger to move forward at a constant rate of

how do you pick a pump?

When it comes to pumps...

on dependability?

Year after year, Fairbanks-Morse Vertical Turbine Pumps deliver outstanding performance. Fool-proof operation requiring no priming . . . automatic solenoid oiler . . . precision construction for smoother flow . . . and backed by the Fairbanks-Morse reputation for quality, they assure dependability *plus!*

on adaptability?

Whatever the job requirements . . . deepwell or close-coupled, electric power, gasoline or Diesel engine, or belt drive . . . Fairbanks-Morse Vertical Turbine Pumps are readily adaptable for all service conditions.

on compactness?

A Fairbanks-Morse Vertical Turbine Pump is compactness itself . . . permits considerable savings in floor space as compared to ordinary pumps of comparable capacity. It requires no complicated piping hook-ups. Installation is easy and economical.

on service?

The Fairbanks-Morse Pump Dealer organization is founded on service. They *know* pumps . . . can offer you unmatched service and assistance. Backed by the Fairbanks-Morse production and engineering resources, they can help you pick the pump that will give you most for your pumping dollar. Fairbanks, Morse & Co., Chicago 5, Illinois.

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STOKERS • RAILROAD MOTOR CARS and STANDPIPES • FARM EQUIPMENT • MAGNETOS

A FEW OF THE COMPLETE LINE OF FAIRBANKS-MORSE PUMPS

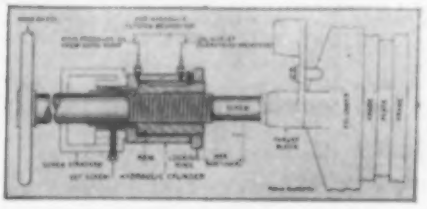
Trash Pump

Side-Suction

Rotary

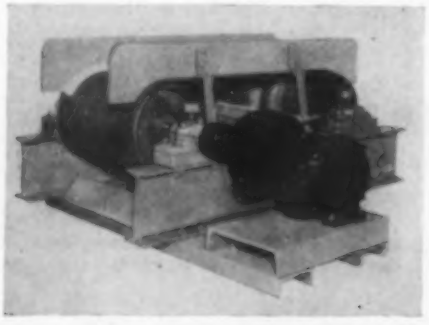
Builtogether

speed. Two plungers in two displacement chambers are employed, with common suction and common discharge connections. There are a total of eight check valves, two on the suction and two on the discharge of each displacement chamber. As one plunger nears the end of its stroke, its speed is slowed at a rate equal to the forward starting speed of the second plunger. Capacity of the pump is fully adjustable in operation. Capacity does not vary with variation in discharge pressure. A variety of construction materials is available, suitable for a wide range of chemicals.



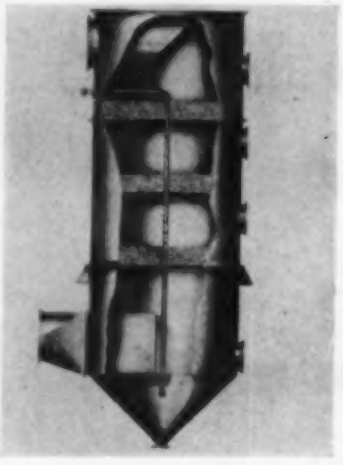
8. Hydraulic Press Closer

KNOWN as the Hydro-Kloser, a new hydraulic closing device, announced by T. Shriver & Co., Harrison, N. J., can be installed readily without alterations on new or old filter presses of this company's manufacture, provided the plate size is 24 in. or larger. This device is a hydraulic ram, operated by a small hydraulic pump, which replaces the usual screw bushing on the inside face of the screw standard. The existing screw of the filter press is used, the interior of the ram being threaded to take this screw. In closing the press the hand wheel is manually turned until the screw begins to exert pressure after which closing is completed by operating the hydraulic pump.



9. Pulley-Type Separator

A COMPLETE line of self-contained horizontal and inclined magnetic pulley-type separators, each incorporating an Alnico magnetic pulley and idler pulley, and an endless belt and drive, has been announced by Dings Magnetic Separator Co., 4740 West McGeogh Ave., Milwaukee 14, Wis. Pulley diameters range from 12 to 30 in., and belt widths from 12 to 60 in. These units are designed to remove tramp iron from a wide variety of materials.



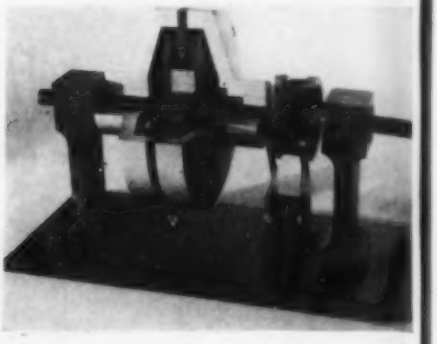
10. Wet Dust Collector

A NEW wet-type dust collector for which extremely high efficiency is claimed has been introduced under the name of Pemasco by Paul E. McKamy & Associates, 8 South Dearborn St., Chicago 3, Ill. The washer contains one or more beds of ceramic packing material in the scrubber and entrainment separation sections. The number of beds is determined individually for each particular problem. The packing is supported on open grids, and a centrally located spray pipe directs hundreds of tiny sprays against the side walls and over the bed. The dust-laden air enters the chamber tangentially at the bottom, passing upward through the sprays and beds and out the top outlet.

11. Washer-Type Precipitator

FOR CLEANING air for industrial and air conditioning purposes, the Raytheon Mfg. Co., Waltham 54, Mass., has introduced an electrostatic precipitator which incorporates a semi-automatic washer for cleaning the cells and ionizers, drying them, and applying precipitator adhesive. Washer cabinets are used in front and in back of the precipitator, and are mounted on wheels for movement across the entire face of the precipitator. The side away from the precipitator is equipped with adjustable louvers, while the side towards the precipitator is open to allow the nozzles on a traveling header to cover the entire precipitator tier. The header travels up and down on an endless chain mechanism, carrying six water nozzles and five adhesive nozzles.

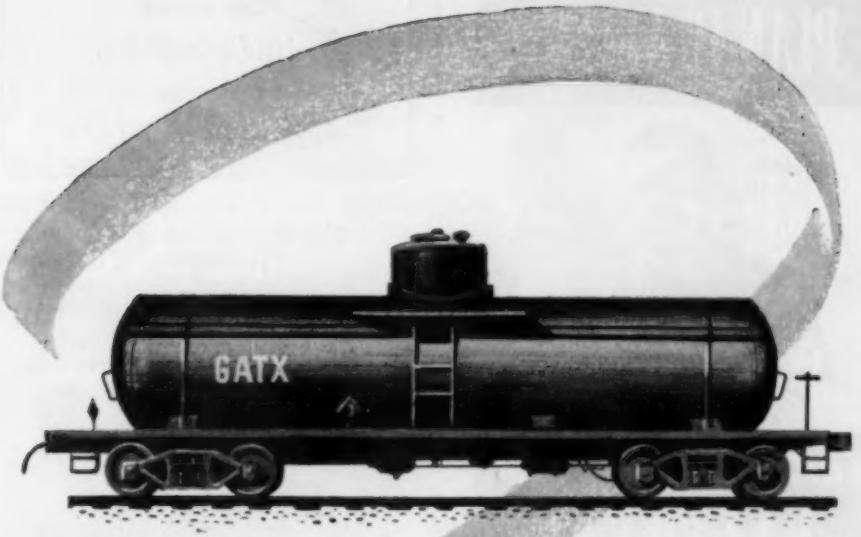
In use, the washer cabinet must be moved into position and the louvers and sliding panels closed. The tier being washed is then disconnected from the power supply, after which pressing a pushbutton sets the automatic washing cycle into operation. It requires approximately 30 min. total elapsed time to wash, dry and apply adhesive to a four-cell tier. The tiers not undergoing washing remain in operation.



12. Magnetic Fluid Clutch

DECIDEDLY interesting possibilities in the field of power transmission, ranging from the requirements of servo mechanisms, to the automatic control of machinery, are suggested by the development of a magnetic fluid clutch by Jacob Rabinow of the National Bureau of Standards in Washington. The novelty of the clutch is based on the discovery that the frictional forces between solid surfaces and certain types of fluid media can be controlled by the application of magnetic fields. Although the clutch can be made in a great many different variations, the simplest type is made of the three elements, a driving shaft with a plate at its end, a driven shaft and plate, with a fluid medium between them consisting of fine iron particles suspended in oil.

When the space between the two parallel magnetic plates is filled with such a mixture and a magnetic field is established between the plates, the magnetic particles form chains which bind the two plates together as tightly as if they were held together with strong spring clamps. Thus it is only necessary to establish such a field, as indicated in the model illustrated here. By controlling the strength of magnetic field, any degree of torque up to locking can be obtained. When disengaged, there is virtually no drag. When engaged, the clutch is said to start



WHEN CAN YOU EXPECT MORE GENERAL AMERICAN TANK CARS?

When more materials are made available General American will build more tank cars. That's plain fact.

Right now, the GATX Fleet has more than 37,000 tank cars, of over 207 specialized types—but still not enough. Our customers have increased volume . . . expanded and acquired new plants—now need more tank cars than ever before. General American plant operations have been enlarged . . . productive capacity and effort has been stepped up, yet the growing demand far surpasses the new cars put into service. We are doing everything possible to relieve this situation, but total car production is controlled by our supply of materials. As fast as materials now on order are made available, we will once again keep our tank car supply equal to demand.

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We make all types of filter cloth for standard equipment.

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for prices. State size, width, quantity, and type of filter used.

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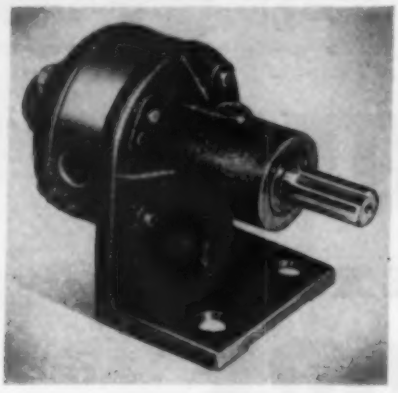
Coupon on pages 169-170

the load with smoothness and absence of chatter. Furthermore, it is claimed that there is a practically complete absence of wear, since all working parts are bathed in oil and such small amounts of wear as might occur simply add to the supply of iron particles.



13. Rotary Pump

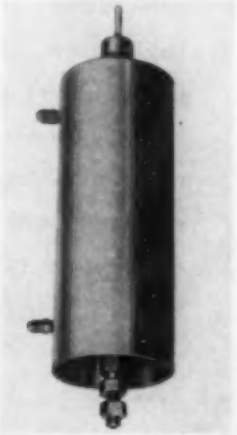
FOR DELIVERY of from ½ to 4 gpm. at pressures up to 125 psi., the Ellipse Corp., 4140 North Kedzie Ave., Chicago 18, Ill., has introduced a novel rotary pump for handling oils and similar liquids. These positive displacement pumps employ a new operating principle, using multiple vanes carried in a fluted rotor which operates either eccentrically in a cylindrical casing, or centrally in an elliptical casing. Such pumps may operate in either direction and it is claimed that ordinary wear does not reduce the pump capacity or pressure.

14. Pressure Cooker

FOR USE in continuous heating, cooling or other sorts of treating of large quantities of materials under pressure, the Blaw-Knox Co., Pittsburgh, Pa., has introduced a new unit consisting of a horizontal cylindrical shell rotating inside a pressure chamber. Feed and discharge are accomplished through barrel valves of special design which are said to allow continuous charging and discharging at pressures up to 15 psig. Although developed originally for use in the soybean processing industry, the new machine is expected to find applications in other fields.

15. Drum Pallet

A NOVEL all-steel skeleton pallet, weighing only 65 lb. and designed to be loaded or unloaded by fork truck, has been announced by Pacific Chain & Mfg. Co., 4200 Northwest Yeon Ave., Portland 10, Ore. As the illustration shows, this pallet is intended for the handling of 55-gal. drums, as well as for barrels and certain other rectangular containers. The pallet is 48x48 in. over-all. A somewhat similar but larger type is suitable for storing empty 55-gal. drums on their sides, six drums per pallet.



16. Selenium Rectifier

SEVERE OVERLOADS can be handled, it is claimed, with a new type water-cooled, industrial selenium rectifier tube that has been put on the market by Clark Electronic Laboratories, Rectifier Div., Box 165, Palm Springs, Calif. These units are oil filled and

Another Beckman development to simplify modern analytical problems...

The Beckman Flame Photometer

- **Quickly attached to Beckman Quartz Spectrophotometer**
- **Invaluable aid in wide range of today's control applications**

The Beckman Flame Photometer shown with the Beckman Quartz Spectrophotometer in operating position.

Leading scientific and industrial organizations have already discovered the many important savings in time and labor, the reduction in waste, and the greatly increased control efficiencies made possible by the Beckman Quartz Spectrophotometer...

NOW FROM the Beckman development laboratories comes another advancement that increases still further the wide-range versatility and adaptability of the Beckman Quartz Spectrophotometer to various analytical and control problems. It is the Beckman Flame Photometer — a compact easily-attached unit that simplifies both qualitative and quantitative analyses of a large number of chemical elements. Its use of a hot flame is an important advantage, for this feature permits excitation of the spectral lines of a larger number of elements, including many heavy metals and alkaline earths — whereas a "cool flame" instrument excites only those of the alkali metals.

MANY APPLICATIONS

The Beckman Flame Photometer is a valuable aid to a wide variety of analytical problems, including water analyses... metal and ore analyses... determination of inorganic traces and impurities in foods, chemicals, biologicals and pharmaceuticals, and in organic materials which can be reduced to inorganic solutions.

Only a small sample is required for a complete analysis and full advantage is taken of the high resolving power and photometric accuracy of the Beckman Spectrophotometer, permitting versatility and sensitivity greater than 0.01 p.p.m. This accuracy far exceeds that obtained with filter-type or other less sensitive instruments... and the hot-flame advantages already outlined further increase the wide range versatility and accuracy of the Beckman Flame Photometer. Write for full details on the many important savings this Beckman development makes possible in modern control applications. Beckman Instruments, National Technical Laboratories, South Pasadena 14, California.

A few of the many BECKMAN Flame Photometer Advantages

▶ **SIMPLE OPERATION:** Samples are atomized and introduced at a uniform rate into a very hot oxygen and gas flame through a specially designed burner. The spectral emission lines of the elements are excited and the Spectrophotometer isolates these lines and measures their intensities relative to a blank or standard.

▶ **RAPID ANALYSES:** Because samples are atomized directly from external beakers, samples can be analyzed very rapidly. A rate of four samples per minute is easily maintained — and re-checks against blanks can be quickly made at any time.

▶ **QUICK, DIRECT READINGS:** Results are instantly and directly readable on an accurately-calibrated dial. No photographic processes or densitometer comparisons are necessary.

▶ **MAXIMUM VERSATILITY:** Unlike "cool flame" instruments which excite the spectral lines of alkali metals only, the hot flame of the Beckman Flame Photometer excites those of many elements, including heavy metals and alkali earths. This advantage, coupled with the very high resolving power and photometric accuracy of the Beckman Quartz Spectrophotometer, permits the accurate analysis of an unusually wide range of elements.

▶ **FULL SPECTRAL RANGE:** Because of the wide spectral range of the Beckman Quartz Spectrophotometer, the Flame Photometer can be used in the ultraviolet, visible and near infrared spectral regions, insuring maximum range and adaptability.

▶ **ONLY SMALL SAMPLES REQUIRED:** Sample consumption rate is less than two-tenths cc. per minute... and complete analyses can be made on samples as small as 5 cc.

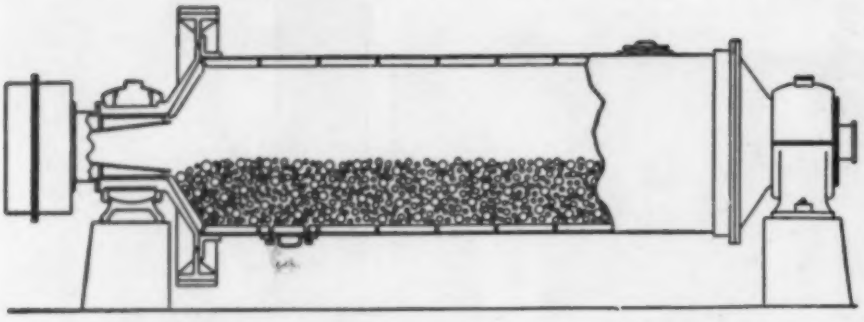
▶ **HIGH SENSITIVITY:** Even very small traces of elements can be quickly and easily detected with the Beckman Flame Photometer... traces as small as a few parts per billion, depending upon the element being determined.

▶ **UNIFORM ACCURACY:** The temperature of the flame and rate of feed of the specimen can be held constant over long periods of time, permitting numerous individual measurements to be made in succession. High accuracy of the readings is not affected by fluctuations in gas or oxygen pressures.

The above are only a few of many Beckman Flame Photometer features. Write for full details!

BECKMAN **INSTRUMENTS CONTROL MODERN INDUSTRIES**

For "Straight-Through" Grinding... HARDINGE TUBE MILLS



Where a finely-ground product is desired in a single pass of the mill—without the use of classifying equipment—Hardinge long Tube Mills fill the bill perfectly. Three types of Tube Mills provide a highly flexible line, especially adapted to the chemical process industries. They are:

1. PEBBLE TUBE MILLS—lined with flint, quartzite, or porcelain—with grinding pebbles of the same material. Used principally in metallurgical wet grinding, chemical processing of acid materials, and the dry grinding of ceramic materials—wherever metallic contamination must be avoided.

2. BALL TUBE MILLS—metal lined and charged with forged steel or cast iron balls—or even boiler punchings. They have greater capacity than the Pebble Tube Mills.

3. COMPARTMENT MILLS—with grates and partitions between compartments. Each compartment contains smaller balls to reduce the product progressively from stage to stage. Adapted for coarser feed than the straight Tube Mill.

In certain applications the Hardinge Tube Mill can also be effectively operated in closed circuit with a classifier. This arrangement has been found useful in the cyaniding of gold and silver ores (wet grinding) cement finishing (dry grinding) and other special processes. ***Write for Bulletin 18-A.***

HARDINGE

COMPANY INCORPORATED

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NEW YORK 17—122 E. 42nd St. • 205 W. Wacker Drive—CHICAGO 6
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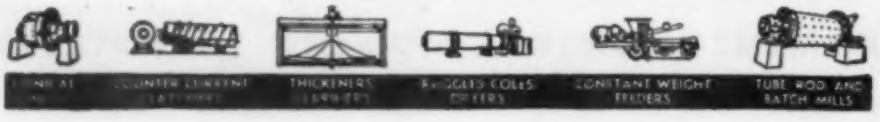


FOR MORE INFORMATION
See Reader Service Coupon on pages 169-170

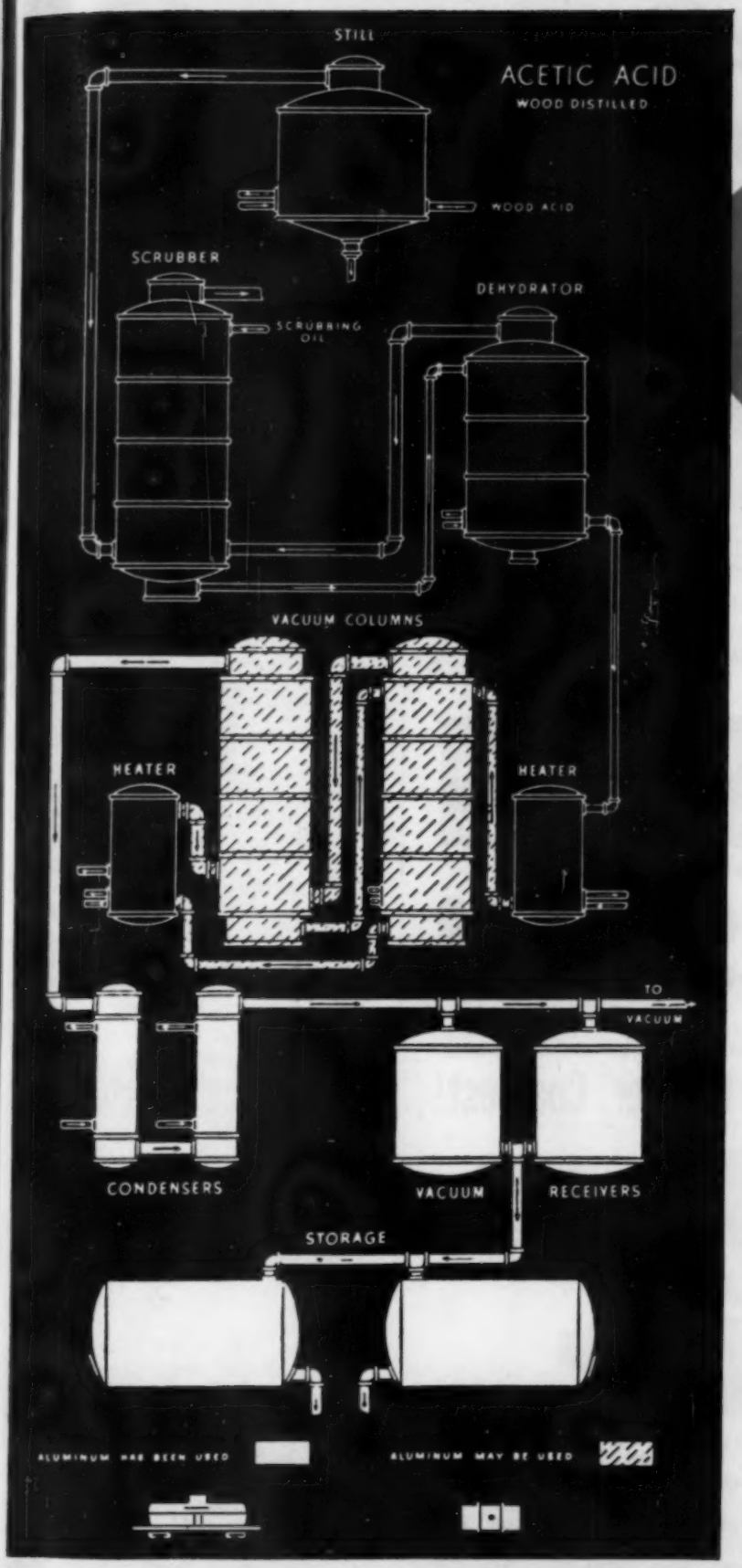
insulated with vacuum-impregnated silicone and fiber glass insulation. They are water-cooled and sealed in stainless steel. It is claimed that they will give five times the output usually expected from a specified selenium unit. They are available in various current and voltage ratings.

17. Floor Conveyor

BOTH FLEXIBILITY and portability are incorporated in a new power conveyor produced by Flexoveyor Manufacturing Co., 315 E & C Building, Denver 2, Colo. Designed to handle bags and cartons weighing up to 200 lb., the unit operates at speeds from 85 to 200 fpm. Two types are actually produced, one rigid, in lengths from 5 to 20 ft., and one flexible, in lengths of 15 ft. up., capable of turning 90 deg. in either direction. Standard width is 20 in., and height, 2 ft. 6 in. Several individual units can be connected together to operate as a single unit. A single motor operates such a series up to 60 ft. in length.

18. Tractor Shovel

AN IMPROVEMENT in its Model HF ¾-cu. yd. Payloader tractor shovel has been announced by the Frank G. Hough Co., 2000 Sunnyside Ave., Libertyville, Ill. The bucket was previously equipped for hydraulic lifting and lowering, but it is now provided with an added hydraulic control which dumps and closes the



MAKING ACETIC ACID?

Here's where to use ALCOA ALUMINUM for Process Equipment

13 years of trouble-free service . . . low maintenance cost . . . no discoloration of product. These are reasons why Alcoa Aluminum is widely used for plant equipment handling glacial acetic acid.

Sheet and plates of Alcoa Aluminum for tanks and shells, Alcoa Aluminum Tubing for heat exchangers, aluminum pipe and fittings protect the color and maintain the quality of the product. Tank cars and drums of Alcoa Aluminum protect its quality in transit.

Most job shops, or your own equipment shop, will have no problems forming, welding, and erecting chemical equipment of Alcoa Aluminum. For engineering advice and technical data, write to ALUMINUM COMPANY OF AMERICA, 2151 Gulf Building, Pittsburgh 19, Pa. Sales offices in 54 leading cities.

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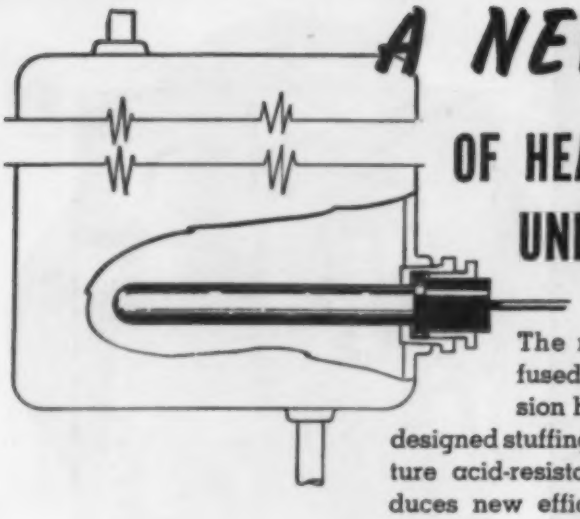

A NEW WAY

OF HEATING LIQUIDS UNDER PRESSURE

The new Amersil* opaque fused quartz electric immersion heater, with its specially designed stuffing box, and high temperature acid-resistant resilient head, produces new efficiency standards when heating liquids under pressure.

In vessels or tanks limited in size, the heater occupies a minimum of space within the liquid or gas area. It provides accurate control over a wide temperature range.

Write today to Dept. "CE" for new bulletin on Amersil heaters.

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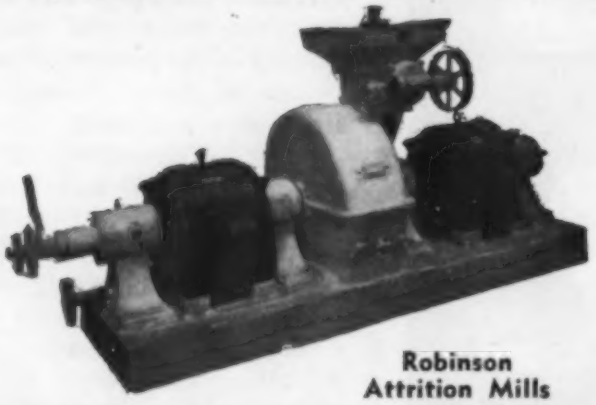
ROBINSON

PROCESSING UNIQUE EQUIPMENT

Fine, Finer, Finest ... Coarse, Coarser, Coarsest!



Robinson Attrition Mills

Attrition Mills for grinding all types of material. Adjustable for coarse or fine grinds. Hard iron grinding plates. Capacities to your requirements. Robinson Processing Equipment is designed by engineers whose reputation is founded upon doing things right. Literature available. Inquiries invited.

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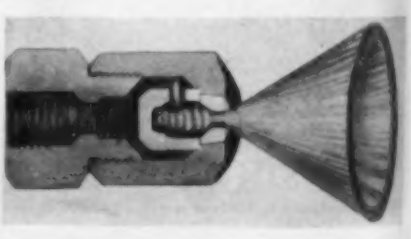
MERCER-ROBINSON COMPANY, INC.

30 CHURCH ST., NEW YORK 7, N. Y.

bucket by finger-tip-actuated hydraulic power. The bucket can be dumped gradually or instantaneously, as desired, and can be closed immediately by the same hydraulic cylinder. According to the manufacturer, this increases speed and ease of operation and decreases wear and tear on the machine and the trucks being loaded.

19. Chemical Feeder

AUTOMATIC feeding of liquid chemicals into systems for the treatment of water or other liquids is the function of a new feeding device introduced by the Liquid Conditioning Corp., 114 East Price St., Linden, N. J. As the illustration shows, the new Liquon Decantrol is a feeder of the type employing a power-lowered swing pipe. The feeding rate is determined by the rate at which the swing pipe is lowered and this rate may either be uniform or it may be determined in proportion to some other flow in the system. The feed pipe does not require manual raising after the tank is empty, since the same motor which lowers the pipe can raise it at greatly increased speed by changing the position of the handle of a selector switch. A signal lamp is provided to show the condition of operation. Changes in feeding rate may be made quickly by an adjustable micrometer dial on the reset timer.



20. Abrasive-Liquid Nozzle

FOR PRODUCING a hollow cone spray pattern with liquids containing abrasive particles in suspension, Spraying Systems Co., 4021 W. Lake St., Chi-

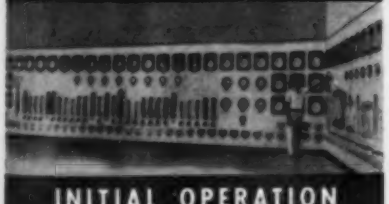
PILOT PLANT

PROCESS DESIGN

MECHANICAL DESIGN

SHOP FABRICATION

FIELD ERECTION



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Upon request, Prufcoat Laboratories will send you a complete Protecto-Graph plan which includes a Protecto-Graph Analysis Sheet plus a sample typical Protecto-Graph. Using your own information, fill out and return the Analysis Sheet. Prufcoat Engineers will then plot a graph showing the cost of painting by your present method compared to the cost of doing the *same* job with Prufcoat. You'll be amazed to see the savings Prufcoat makes possible. So don't delay — get proof — get your Prufcoat Protecto-Graph Plan — clip and mail the coupon below *today*.

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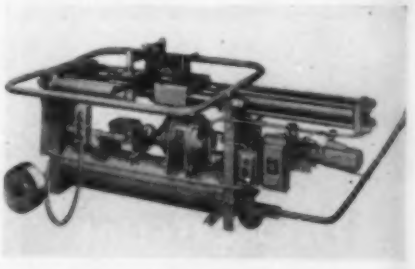
FOR MORE INFORMATION
See Reader Service Coupon on pages 169–170

cago, Ill., has introduced a new nozzle containing a tungsten carbide vortex chamber and orifice insert. In one application reported, the life of the new nozzle was approximately 150 times longer than that of a standard nozzle. The nozzle body and retainer cap are of 18-8 stainless. These new Whirljet nozzles are available in six standard sizes.

21. Armored Quartz Piping

To provide protection and at the same time to permit working at pressures above the normal limits for fused quartz, Amersil Co., 900 Passaic Ave., East Newark, N. J., has developed a line of armored quartz piping, consisting of opaque fused quartz, protected and reinforced with an acid-resistant, high-temperature laminated plastic armoring. The armoring is light in weight, resistant to thermal shock, and shatterproof. It is available in all sizes, together with valves, fittings and auxiliary equipment.



22. Hydraulic Bender

Designated as Type 1402, a new ram type hydraulic bending machine of portable construction has been announced by Wallace Supplies Mfg. Co., 1300 Diversey Parkway, Chicago, Ill. The new machine is capable of bending extra heavy steel pipe up to 2 in. in diameter while special dies are available for bending angle iron, channels, flat bars and other shapes. The machine can bend up to 180 deg. in one continuous operation and may be used also for forming pipe coils.

23. Equipment Briefs

Continuous automatic recording of hydrogen sulphide content of gases in concentrations between 2 and 500 ppm. is provided by a new automatic

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★ **PRECISION-BUILT MOTORS**—Reliance Precision-Built A-c. and D-c. Motors provide dependable power for all models—fit perfectly with gear unit.

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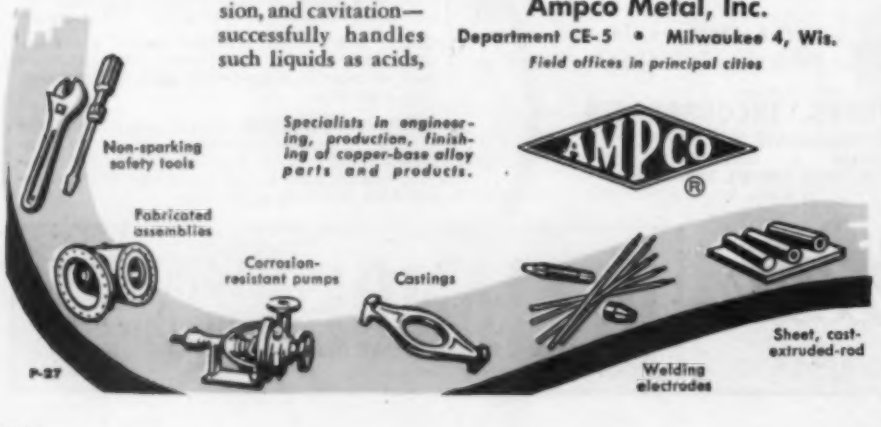

analyzer offered by the Rubicon Co., Ridge Ave. at 35th St., Philadelphia 32, Pa. The instrument is based on a design developed and utilized for a period of years by the Du Pont Co. The principle employed is that of the darkening of a white reactive tape and the automatic photoelectric comparison of the reflectance of this tape with that of a standard. The frequency of the automatically measured and recorded tests, of which the instrument is capable, depends on the hydrogen sulphide concentration.

24. An equipment rental-purchase plan applying to its new pilot-plant rotary vacuum filter has been announced by Filtration Engineers, Inc., 858 Summer Ave., Newark 4, N. J. Part of the rental fee may be applied to the purchase price of either the pilot plant filter (or a larger filter of this company's manufacture) if the renter later decides to purchase. The pilot plant filter in question has a drum area of approximately 10 sq. ft. It is equipped with a string discharge and a washing mechanism.

25. A new rough vacuum switch and a vacuum valve have been announced by Skaneatales Mfg. Co., 122 Dickerson St., Syracuse 2, N. Y. The switch is designed to operate at selected subatmospheric pressures from 26 in. to 5 in. of mercury. The valve has no mechanical movement of components to atmosphere. It is said to use a simple, direct-sealing principle, to be non-trapping and to have a high area valving seat.

26. Nylon, which is now going into an increasing number of industrial applications, has been announced as the construction material of a bourdon tube employed in a new pressure gage anounced by Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn. The new gage movement is said to outwear any other type, even under the most severe conditions of vibration and pulsation.

27. Where relatively high handling speed is necessary with light loads up to 250 lb., a new 250-lb. capacity Zip-Lift is available from the Harnischfeger Corp., Milwaukee 14, Wis. The hoist has various features not usually found in the low-priced field, including push-button control, double brakes and genuine wire rope.

28. Double-corrugated, one-piece skid platforms made of aluminum have been announced by Union Metal Mfg. Co., Canton, Ohio. Light weight is claimed, combined with exceptional strength.

NEW PRODUCTS AND MATERIALS

Richard W. Porter, ASSISTANT EDITOR

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51. Fire-Extinguisher Fluid

FIRST used as a fire-extinguisher fluid by the German military, chlorobromoethane is now being manufactured by the Michigan Chemical Corp., St. Louis, Mich. Given the brand name CB, this compound has been studied and tested over the past three years by its manufacturer. Chlorobromoethane is claimed to be more effective against various kinds of fires than other common extinguishing agents, and is less corrosive than carbon tetrachloride.

CB has the formula CH_2ClBr. It has a boiling range of 151-156 deg. F., freezing point of —123 deg. F., with specific gravity at 68 deg. F. of 1.930, and a vapor pressure of 110 mm. Hg at 68 deg. F. Since it is a low boiling volatile liquid with a low freezing point, it can be used in all types of vaporizing liquid extinguishers. Where a pressured extinguisher is required, the extinguisher may be pressured up readily with carbon dioxide or carbon dioxide and nitrogen. CB is water white in color and has a chloroform-like odor.

This new fire-extinguishing fluid has been tested by the Army Air Forces, Navy, and Civil Aeronautics Authority as well as a number of fire-extinguisher manufacturers, the Underwriter's Laboratories, and the Factory Mutual Laboratories. Full reports on the tests are not available, but indications so far are that chlorobromoethane is superior to the fire-extinguisher grade of carbon tetrachloride. It appears to be more stable in the presence of flames than many compounds used for this purpose.

From the standpoint of corrosion, CB is said to be less corrosive than carbon tetrachloride and when it is kept dry there is practically no corrosive action on steel, brass or lead. However, it rapidly corrodes aluminum, magnesium and zinc. Tests have shown that this new material is less toxic than methyl bromide. The handling of CB should be carried out with the same precautions as with other halogenated hydrocarbons such as carbon tetrachloride, chloroform and trichloroethylene. According to the manufacturer, CB is not available to the public, but will be sold only to makers of fire protection equipment.

52. Sponge Rubber

RECENTLY developed by the Commonwealth Engineering Co., Dayton, Ohio, is a new non-flammable low-cost sponge rubber. Given the brand name of Spon, this material can be cast in sheets and in open molds; continuously produced at high speed in sheet form; or can be delivered through a hose where it sponges at the nozzle. It is a tough, resilient material, and gives a cushioning effect even in thin sections. It is claimed that the new product can be applied and vulcanized directly to upholstery materials, and to the backs of rugs and carpets to provide resiliency as well as flame resistance. It may be vulcanized to fiberboard and boxboard to provide a protective lining for cartons used in the shipment of various fragile products.

FOR MORE INFORMATION
See Reader Service
Coupon on pages 169–170

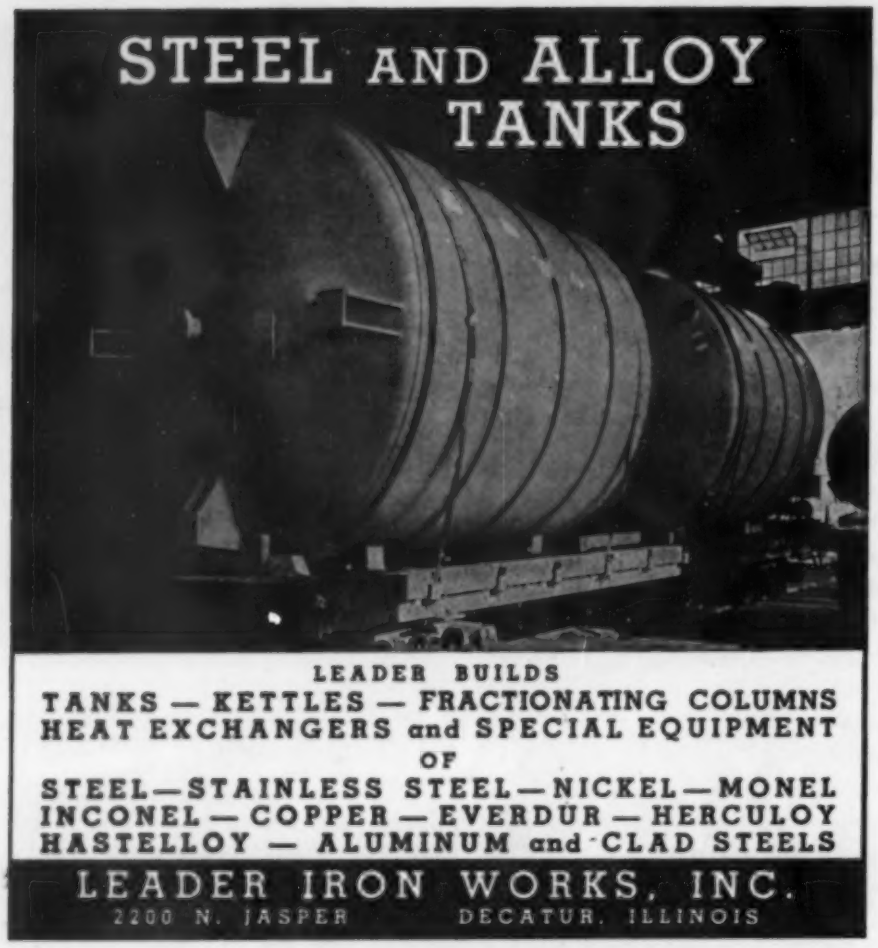
53. Thermoplastic

Now manufactured by the United States Rubber Co., New York, is a new, tough, light weight thermoplastic material, claimed to have good electrical insulating properties and a low rate of heat conductivity. It is claimed to be non-corrosive and stable under changing atmospheric conditions and to possess high impact strength, low water absorption and good insulating properties. Some physical properties are: Specific gravity at 20 deg. F., 1.04; softening point in deg. F., 160-120; tensile strength in psi., 2,000-9,000; elongation in percent, 25-130.

Having the brand name of Versalite, this new material can be formed into irregular and compound shapes as large as 5 by 10 ft. It can be calendared to thicknesses as low as 0.020 in. and may be made with various finishes. Versalite will not chip or warp and is resistant to gasolines, oils and most commercial cleaners. Suggested applications include luggage, radio cases, and component parts for boats, automobiles, etc.

54. Industrial Inks

Two complete lines of fast-drying industrial inks for machine or manual marking have been recently announced by Neehi Protective Coatings, Inc., 340 West Hoffman Ave., Lindenhurst, N. Y. The first of these is a machine-marking ink for use with automatic, semi-automatic and manual marking devices using rubber or steel type. Inks may be fed to the type by felt or metal rollers. The second line consists of manual mark-



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36-29 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

ing inks for use with marking brush, stencil brush or spray gun. These can be thinned before applying with pen points for fine markings. Both lines of inks are available in a wide range of color, are fast drying and can be regulated to suit particular conditions of the application. They are claimed to be waterproof, weather-proof, fade resisting, oil, solvent, acid and alkali resisting, and are made to stand severe handling. They can be used on metal, wood, paper, rubber, glass, leather, plastic, ceramics, and other materials.

55. Packaging Adhesives

A NEW shipping case sealing adhesive, for use with automatic case sealing machines has been recently made available in commercial quantities by Paisley Products, Inc., 1770 Canalport Ave., Chicago 16, Ill. Designated as Boxseal Glue, this material may be described as a liquid converted starch derived adhesive. It has properties that enable the glue to coat a thinner, more cohesive film on the container board without excessive penetration into the board fibers. The glue remains on the surface to make positive contact with the container flaps when they are pressed together.

One property of the glue is that it remains in a fluid condition indefinitely, permitting it to be piped directly to the machine glue pans without danger of solidifying in the pipes. It is claimed to not crust or foam over and contains no silicate or any inorganic fillers. It is said to be non-toxic, odorless and free from staining tendencies. Glue may be diluted depending on the porosity of the container board in use. It is available in 55-gal. drums and 5-gal. pails.

56. Mildew Proofing Agent

DEVELOPED during the war by the National Bureau of Standards, Washington 25, D. C. is a fungicidal dressing for the treatment of leather goods. Important ingredients of this leather dressing are 20 precent of a mixture of equal parts of neatsfoot oil and mineral oil for preserving the flexible characteristics of the leather, and 2 percent of paranitrophenol, a fungicidal material for preventing the growth of mildew. The other components are 10 percent cyclohexanone, used because of its solvent power, and 68 percent of either perchloroethylene or Stoddard's solvent. Perchloroethylene is preferable because it is non-flammable. The compound should be applied so that the amount of the active ingredient (paranitrophenol) is not greater than 0.35 percent of the

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- ... Extensive facilities of 5 modern plants.

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ETHYL PARASEPT
PROPYL PARASEPT
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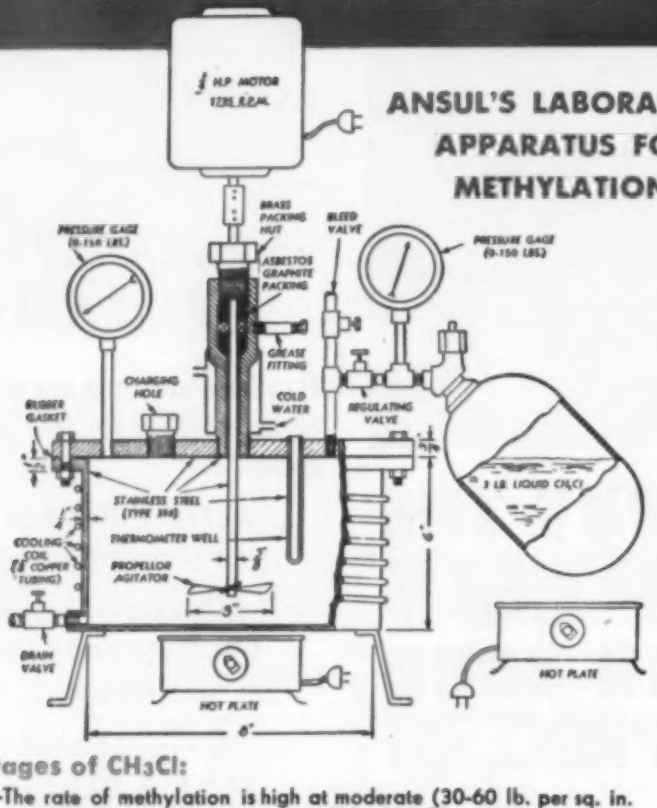

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3—Can be conveniently weighed, metered, etc.
4—A low-priced chemical available in cylinders and tank cars.

Recommended for methylation of amines, phenols, alcohols, hydrocarbons and others.

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PHYSICAL PROPERTIES

Chemical formula	CH_3Cl
Molecular weight	50.491
Color (gas or liquid)	Colorless
Odor	Ethereal, non-irritating
Melting point	−144° F. (−97.6° C.)
Boiling point	−10.65° F. (−23.7° C.)
Critical Temperature	289.6° F. (143.1° C.)
Critical pressure	969.2 lbs. per sq. in. abs.
Solubility	Methyl chloride in water—3 to 4 volumes methyl chloride vapor in 1 volume of water at ordinary temperatures and atmospheric pressure—methyl chloride in alcohol—readily soluble.
Specific gravity of liquid	.909

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FOR MORE INFORMATION
See Reader Service Coupon on pages 169-170

weight of the leather and it should not be used for articles that make intimate contact with the skin such as hat bands or gloves. Its greatest use during the war was for treatment of shoes used by troops in the South Pacific Areas during the war. It is now being used for the treatment of shoes and other leather items which are placed in storage as well as for reconditioning combat boots that have become mildewed and stiffened during storage.

57. Anti-Corrosive Coatings

NEW anti-corrosive coatings have recently been announced by Industrial Metal Protectives, Inc., Dayton 2, Ohio. Known as Zincilates, this air-dry coating is useful for covering sheets, pipes and forms, and is adaptable to production line application by dipping, spraying, brushing or roller coating. It has been used on air conditioning equipment, bakery equipment, automotive parts and assemblies, valves, pipes, screens and other products. It forms a flexible film that will not break readily. It may be used as an undercoat for enamel, paint, or wrinkle finishes.

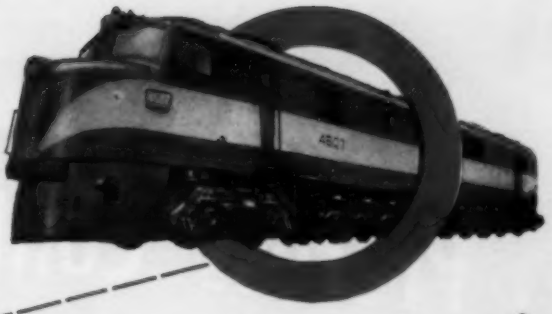
58. Nylon V-Belt

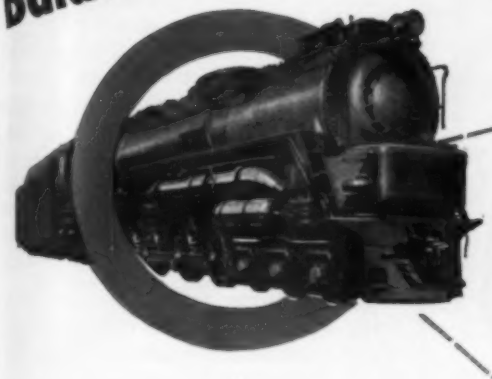
HAVING greater strength and longevity than the conventional V-belt, a nylon-reinforced V-belt has been developed by the United States Rubber Co., New York. This new belt contains nylon cord covered with synthetic rubber compound and is capable of withstanding the deteriorating effects of heat and oil. The belt is recommended for power transmission on equipment subject to rough usage. The price of this new type of belt will be about 40 percent above that of standard cotton cord construction.

59. Starch

RECENTLY announced by the National Starch Products, Inc., is the development of a new type of starch for use in making clear, stable, and unusually viscous pastes. Known as Clear Flo, this new starch swells at considerably lower temperatures than ordinary starches. It is available in both high and low viscosity grades.

Baldwin Locomotive Works find





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5. Uniform appearance
6. Streamlined—light in weight
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Nichols Herreshoff and Bethlehem Wedge Multiple Hearth Furnaces are designed to control accurately the materials they process. Ore flow and shaft speed may be quickly regulated. Air and fuel in controlled amounts can be introduced at any hearth. Exit gases in controlled relationship can be withdrawn from any hearth. Control samples can quickly be obtained at access doors at each hearth. All of this and more at a higher degree of thermal efficiency.

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University Tower Bldg., Montreal, Can.

THERMAL ENGINEERING SPECIALISTS

and is easily prepared by adding hot water to a suspension of the starch in cold water. Suggested applications are as follows: for desensitizing gum in lithography, as a paper sizing ingredient and as a translucent, smooth, non-congealing thickener for cosmetic creams and lotions. Other uses suggested for Clear Flo are as thickening, binding or dispersing agents in textile finishing and sizing, in cleaning compounds, in water colors and paints, wall paper and poster pastes, in the dispersion of pigments for wet grinding, and in boiler feedwater to prevent scale formation.

60. Insecticide

After three years of exhaustive tests, a new insecticide is now available in commercial quantities from the U. S. Industrial Chemicals, Inc., 60 E. 42nd St., New York, N. Y. Known as Pyrenone, this new, non-toxic material can be used in oil sprays, aerosols, emulsions, dusts, or wettable powders, and combines quick knock down power and high mortality to insects.

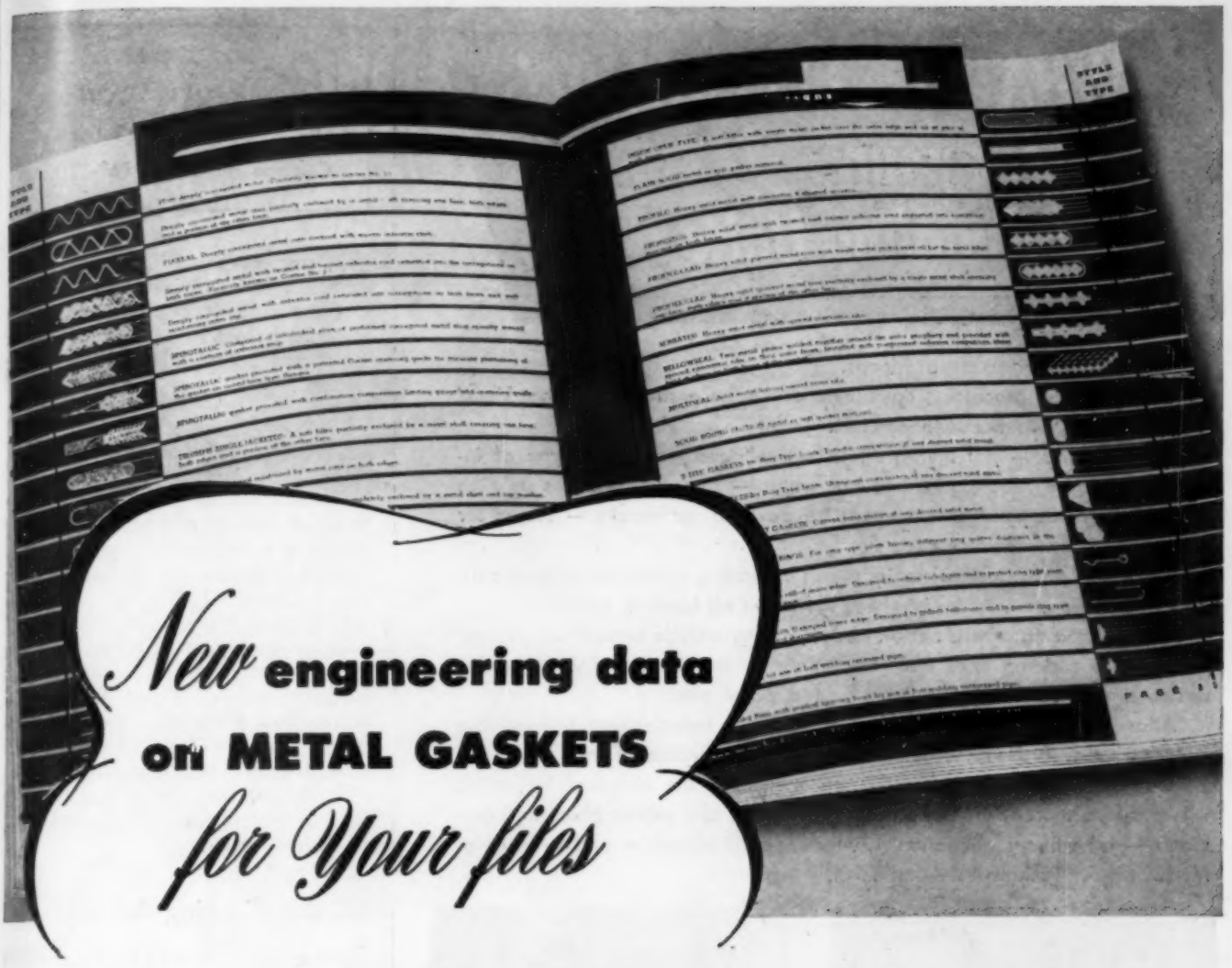
The name Pyrenone is used to designate a group of insecticide concentrates obtained by combining ether piperonyl cyclonene or piperonyl butoxide with pyrethrum. Both piperonyl cyclonone and piperonyl butoxide are synthetic organic chemicals which are effective as insecticides when used by themselves. However, when used with pyrethrins they combine their own killing power with the fast knock-down power of pyrethrum to make an effective combination.

Pyrenone has been found valuable in the control of insects which attack stored grain and can be used as a spray for the interiors of grain bins, elevators, box cars, holds of ships and wherever grain or cereal products may be stored. It is also effective against a wide variety of other types of insects, that attack plants and animals. Non-toxic characteristics make it safe for use in the protection of all types of food products.

61. Automobile Specialties

Two new specialty products for use on automobiles are announced by the E. I. du Pont de Nemours & Co., Wilmington 98, Del. The first of these is Du Pont tire black, a ready-mixed liquid dressing for use on tires, rubber mats and running boards. Retailed in pint cans it is ready for use without thinning. This tire dressing dries quickly after application with a paint brush and gives a durable black satin finish.

The second of these products is a



New engineering data on METAL GASKETS *for Your files*

. . . cross-sections and construction details included in new Johns-Manville Goetze catalog

THE HANDY reference chart shown above is one of many features of the new J-M Goetze Gasket catalog which make it easier for you to select metal gaskets. It gives cross-sections and construction details of more than 30 basic Goetze Gasket designs that are available now to meet your requirements.

Here, too, you will find complete descriptions of such noteworthy developments as the Goetze Bellowseal—the gasket with the automatic self-sealing expansion joint for high temperature, high pressure service . . . the versatile Spirotallic with its combination of high mechanical strength and resilience . . . the Goetze V-Tite, a special solid metal gasket for sealing ring type joints . . . as well as the many styles of boiler, cylinder head and heat exchanger gaskets in the complete Goetze line.

In fact, there isn't an important metal gasket development which is not covered—or a single metal gasket problem to which the new J-M Goetze Gasket catalog won't help you find a practical, money-saving answer!

If you buy or use metallic gaskets, you will want to have full information about these latest Goetze developments at your finger tips. Write, on your company letterhead, for your copy of the new Goetze Gasket catalog. Address Johns-Manville, Box 290, New York 16, N. Y.

SEND FOR YOUR COPY TODAY

The new Goetze Gasket Catalog containing the handy gasket reference chart shown above has 48 pages of up-to-the-minute gasket information. Write for your copy today.

JM PRODUCT

Johns-Manville *Goetze* Gaskets

WHAT LIFE EXPECTANCY . . . for your Acid Handling Units?

"Down Time" earns no dividends.

With chemical processing equipment of Atlas Construction "Down Time" is out — along with maintenance costs.

Proof against — not merely "resistant to" every specified type of industrial corrosive, also steam and hot water — and temperatures as high as 360° F., Atlas Construction needs no days off for repairs — serves for years without maintenance cost.

You'll find Atlas Construction in plants of leading producers of chemicals, steel and other commodities involving the use of all kinds of corrosives.

With Atlas Units, size is not an obstacle. They include tanks (from platers' portables to pickling units 300' and more in length) also floors, towers, stacks, drains, sewers, neutralizing and disposal pits.

Atlas Service is national — and complete. It includes quickly available materials, proven design and, when desired, supervision of installation.

Our engineers, with exhaustive experience in the chemical industries, will study your problem, make recommendations and submit plans and estimates — all without obligation. Contact nearest branch — and write us at Mertztown for Technical Bulletin T5-B.

Chemical Saturator, lined with Atlas acid-proof brick, joined with Carbo-KOREZ acid proof cement.

Steel Tanks — lined with Atlas Rewbon (seamless rubber) and brick joined with Carbo-KOREZ. These tanks handle varying concentrations of phosphoric acid at temperature to 230° F.

THE Atlas Mineral

PRODUCTS COMPANY OF PENNA.

MERTZTOWN, PENNSYLVANIA

*ATLANTA 3, Ga., 452 Spring St., N. W.
*CHICAGO 1, Ill., 333 No. Michigan Ave.
*DETROIT 2, Mich., 2970 W. Grand Blvd.
NEW YORK 16, N. Y., 280 Madison Ave.
PITTSBURGH 27, Pa., 4921 Plymouth Rd.
PHILADELPHIA, Pa., 355 Fairview Rd. Springfield, Pa.
ST. LOUIS 8, Mo., 4485 Olive St.

THE ATLAS MINERAL PRODUCTS CO. OF TEXAS, INC. Box 252, Houston 1, Texas

*BERKELEY 2, Calif., 605 Addison St.
DALLAS 5, Tex., 3921 Purdue St.
*DENVER 2, Colo., 1921 Blake St.
*HONOLULU 2, Hawaii, U.S.A.
OMAHA, Neb., 423 South 38th Ave.
*LOS ANGELES 12, Cal., 172 S. Central Ave.
NEW ORLEANS 12, La., 208 Vincent Bldg.
*SEATTLE 4, Wash., 1252 First Avenue, S.

*Stock carried at these points

IN CANADA: Atlas Products are manufactured by H. L. BLACHFORD, Limited, 977 Aqueduct Street, Montreal, P. Q., 86 Bloor St. W., Toronto, Ont.

FOR MORE INFORMATION
See Reader Service Coupon on pages 169-170

polishing compound for use with an electric automobile polishing machine. Designated as No. 7 power polish, this material is sold in 1-gal. cans, and is intended for use by dealers and service stations.

62. Rustproof Coatings

PREVENTION of rust and corrosion to metal surfaces can be accomplished with a new rustproofing coating made by Kano Laboratories, 75 East Wacker Drive, Chicago 1, Ill. This rustproofing compound is applied to the metal cold by dipping, spraying or brushing, and dries in about 15 min. to a clear hard dry surface. Tough flexible and non-porous when dry, it can be removed readily with any petroleum solvent, or it may be left as an undercoat prior to painting. It is suggested to prevent rust on raw metal stocks and on finished parts.

63. Dry-Cleaning Solvents

Now available in limited quantities is a new odorless petroleum solvent made by the Socony-Vacuum Oil Co., Inc., 26 Broadway, New York 4, N. Y. The solvent possesses an almost imperceptible bland odor that is free of aromatic, naphthenic and unsaturated carbons which normally account for odors in such solvents. These compounds are removed in the refining process rather than from subsequent additions of chemicals or masking agents.

64. Magnetic Alloy

A PERMANENT magnet material possessing higher external energy than has been heretofore possible is now manufactured by a new sintering process developed by the Metallurgical Division of General Electric Co., Pittsfield, Mass. Known as sintered Alnico 5, this new material is claimed to be especially adaptable where small, powerful magnets with high magnetic properties are required. It is expected to find extensive use in the electronic, electrical, instrument and novelty fields. Sintered Alnico 5 has unusually high tensile properties and can be produced with smooth surfaces and close dimensional tolerances.

YALE introduces an IMMERSION HEATER with a NEW TWIST to save you money

Cut costs with this *new* YALE Rod Type Immersion Heating Unit. The YALE designed single element construction gives the same amount of heat in a given space as is achieved with the usual double heating unit!

Furthermore, YALE heat is *uniform* heat. YALE made units result in:

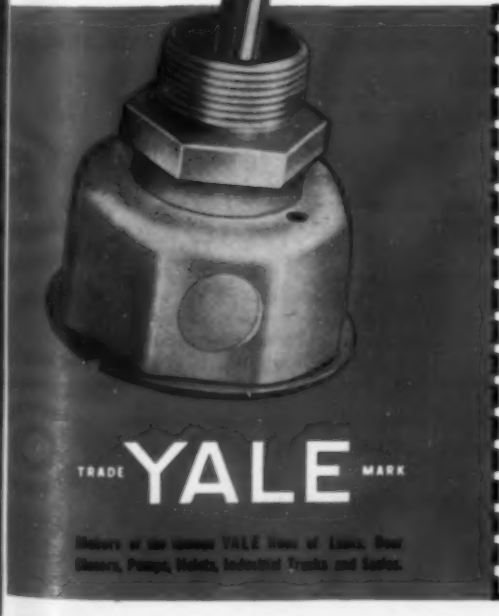
1. Uniform distribution of the refractory within the sheath for *uniform insulation.*
2. Accurately centralized location of the resistor—equidistant from the sheath throughout its length—for *uniform heat transfer.*

Prompt shipment on Rod Type Heating Units—first of a *complete* YALE line of electric heaters.

Please use coupon below to receive full information on this and other types of YALE *Electric* Heating Units.

YALE *Electric* UNIFORM HEAT

THE BRIGHT SPOT IN ELECTRIC HEATING



THE YALE & TOWNE MANUFACTURING COMPANY

YALE *Electric* HEATING UNIT SALES

Room 1037, Chrysler Building, New York 17, New York • Murray Hill 9-6700

Please send catalog with full information on YALE *Electric* Rod Type Heating Units. Our proposed application is described below:

_____

_____

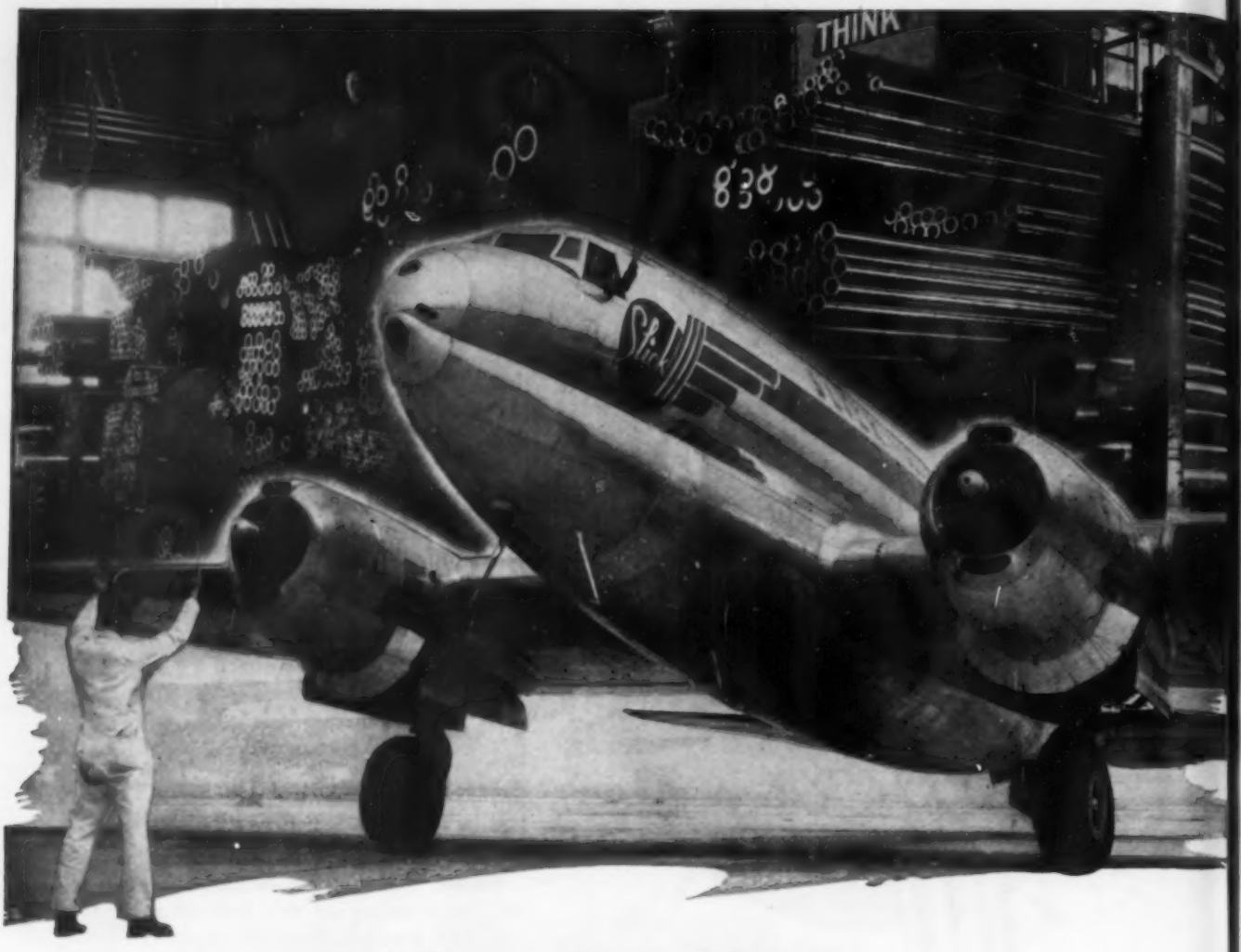
NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



Taking the Distance Out of Your Steel Problems

Urgently needed by a Los Angeles engineering company, was a large shipment of stainless steel pipe in a special size. A call to the Ryerson plant in Los Angeles disclosed that the required pipe was not in Los Angeles stock, but *was* on hand in another city.

Ryerson Los Angeles immediately phoned Ryerson in Chicago. Could Chicago supply the desperately needed pipe? Chicago could—and did! The material was quickly trucked to a Chicago airport, flown to Los Angeles, and delivered at the customer's plant the following morning, less than 24 hours after the order was received.

That's how Ryerson—when the steel *is* available—can take the *distance* out of your steel problems. That's how the twelve closely cooperating plants of the Ryerson Steel-Service System often accomplish the seemingly impossible in an incredibly short time. And that's the sort of far-reaching service you can look for when you contact any Ryerson plant for any steel requirement.

Joseph T. Ryerson & Son, Inc. Plants at: New York, Boston, Philadelphia, Detroit, Cincinnati, Cleveland, Pittsburgh, Buffalo, Chicago, Milwaukee, St. Louis, Los Angeles.

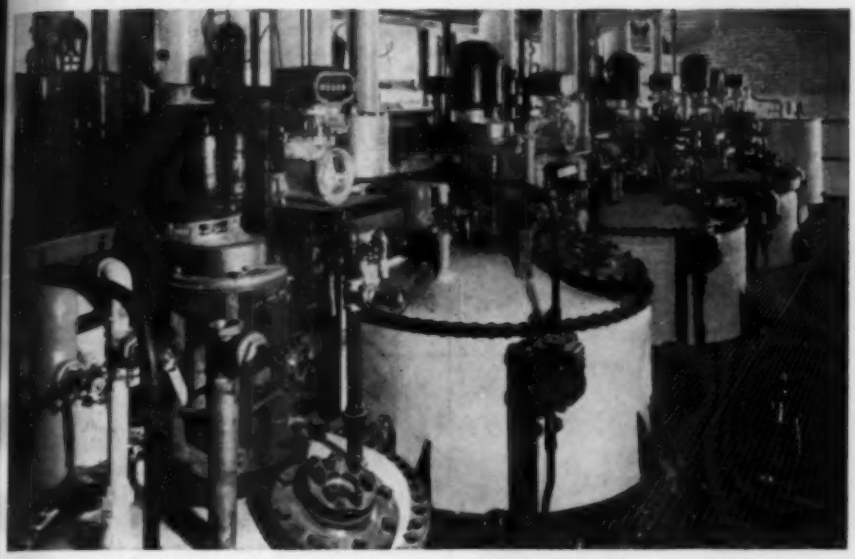
PRINCIPAL PRODUCTS

Bars—hot and cold rolled	Mechanical Tubing	Tool Steel
alloy steel	Boiler Tubes and Fittings	Wire, Chain
reinforcing	Allegheny Stainless—	Bolts, Rivets
Structurals	sheets, plates, shapes,	Babbitt
Plates—	bars, tubing, etc.	Metal Working Tools
Inland 4-Way Floor Plate	Sheet and Strip Steel	& Machinery, etc.

RYERSON STEEL

CHEMICAL ENGINEERING NEWS

Richard F. Warren, ASSISTANT EDITOR



REACTION KETTLES at the American Chemical Paint Co. plant in Ambler, are part of the new unit that produces cholesterol from wool grease.

Cholesterol From Wool Grease Produced at Ambler Unit

AUTOMATICALLY controlled, a new American Chemical Paint Co. plant at Ambler, Pa., is turning out cholesterol from wool grease. Twenty-two skilled workers run the three-story plant designed by Dr. Gustave T. Reich of Phildelphia and built at a cost of $400,000. They first remove water and dirt that is in the grease when it comes from wool scouring mills. Refined grease is then saponified and the soap separated off. Unsaponifiable matter gives up cholesterol after solvent extraction. Inert gas around the cholesterol keeps it from decomposing while it is distilled, filtered, precipitated, selectively dissolved and finally dried.

Cholesterol, a white crystalline alcohol, is the base for synthetic production of the hormones, testosterone and estradiol. Spinal cords and brains of cattle have yielded small amounts of cholesterol. Up to now wool grease, though known to be a rich source of cholesterol, was too complex a material with which to work. Actually a wax because it contains no glycerol, wool grease was studied for more than five years by the American Chemical Paint Co. before it developed the process now in use in the new plant.

CMRA Meets In Boston As MIT Plays Host

REPRESENTATIVES of 120 American and Canadian chemical companies met in Boston and Cambridge last month at a joint meeting on chemical market research. The meeting was sponsored by the Chemical Market Research Association and Massachusetts Institute of Technology. Chief speaker of the session was Brig. Gen. Georges F. Doriot, professor of industrial management, Harvard University. He spoke at the evening session held at the Copley Plaza Hotel. At the morning session, Prof. Alex Bavelas, MIT department of economics, spoke on psychological aspects of interviewing. Prof. Ross M. Cunningham and Prof. Gerald B. Tallman discussed the connections between industrial and consumer marketing research.

At the afternoon session, conducted by John J. Healy, Jr., Monsanto Chemical Co., Richard B. Schneider, Arthur D. Little, Inc., discussed some of the major areas of industrial marketing research. Lauren B. Hitchcock, vice president of Quaker Oats Co., explained the development of an industrial market for furfural. R. F. Elder, vice president of Lever Brothers, talked on marketing research as an aid in top policy planning.

More Coke Ovens Planned For Chicago Area

MORE coke ovens will be producing coal chemicals in 1949. Peoples Gas Light and Coke Co. has awarded a contract to Koppers Co. to erect a battery of 51 byproduct underjet coke ovens. They will be located at the Crawford Ave., Chicago plant. These ovens will increase present plant capacity by 40 percent. Work on the new units will be started at once and work will be pushed so that all ovens will be in operation next year.

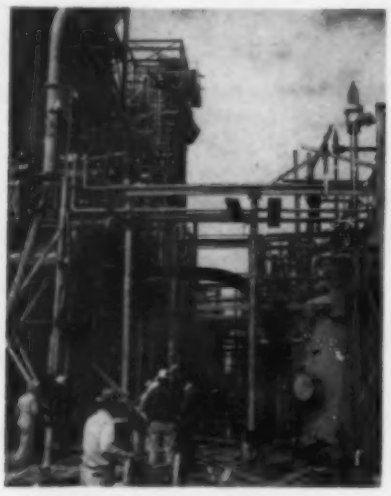
James A. Lee

Electrochemical Society Elects President

ANNOUNCEMENT of the results of the recent election of officers was made at the annual business meeting

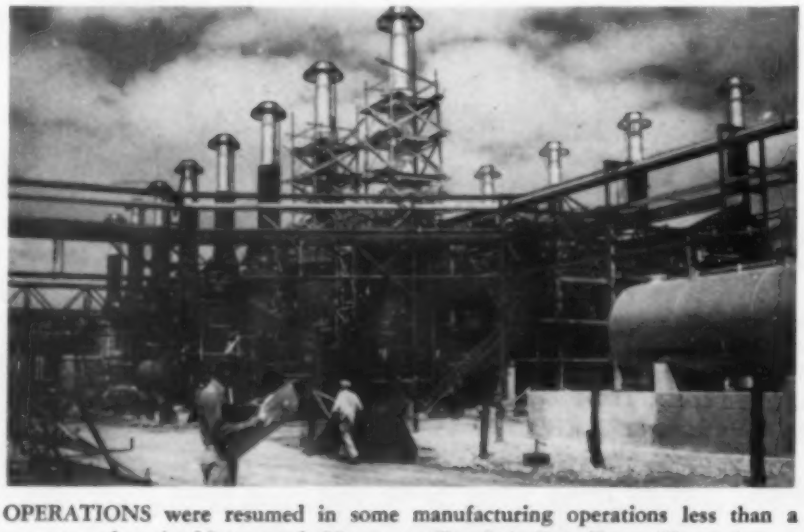
TEXAS CITY: One Year After

THEN pipes and lines were twisted and distorted at Monsanto's plant.



NOW order has replaced chaos at the same unit one year later.

RECONSTRUCTION meant long hours of hard work directed from this Quonset Hut. A permanent administration building will replace it.



OPERATIONS were resumed in some manufacturing operations less than a year after the blast struck Monsanto Chemical Co.'s Texas City unit.

of the Electrochemical Society, held in Columbus, O. last month. James A. Lee, managing editor of *Chemical Engineering*, was elected president. He succeeds George W. Heise. Ralph M. Hunter was made vice president. Other vice presidents are A. L. Ferguson and C. L. Faust. R. M. Burns and W. W. Winship were re-elected secretary and treasurer respectively.

Highlights of the meeting included sessions on corrosion, luminescence, rare metals, electrothermics, and general electrochemistry. The annual banquet was held in the ballroom of the Deshler-Wallick Hotel. At that time awards were made to Henry Leidheiser, Jr., (Young Author's Prize) and Austin E. Hardy (Turner Book Prize).

Shell Is Building Petroleum Additives Unit at Martinez

Now UNDER way at Martinez, Calif., is construction work on a new plant of Shell Chemical Corp., San Francisco, for the manufacture of petroleum additives. Special emphasis will be placed on quality, an important factor in the effective functioning of additives. Production equipment will be made of special materials to help guard product quality in all stages of manufacture. The additives will be used in lubricating oils and other petroleum products to increase life and performance. Completion is scheduled for late this year.

Northwest May Get Natural Gas From Canada

NATURAL gas for the fuel-scarce Northwest and British Columbia may be a reality by 1950. Definite plans are being made by Northwest Natural Gas Co., New York, to tap the large reserves near Calgary, in Alberta, and to lay a $78,000,000 line that would serve a major segment of the Northwest. An application has been filed with the Federal Power Commission, states R. B. Hand, vice president, and negotiations with the Canadian government are progressing. A final market survey will be conducted by Ebasco, Inc., New York.

The 600 miles of 24-in. pipe would start at Kingsgate, B. C., then probably go to Spokane, Walla Walla, Portland and Seattle. Another 150 miles of 18-in. pipe would go to Vancouver, B. C. A number of lateral lines are projected; one would serve Consolidated Mining & Smelting Co. of Canada at Trail, B. C.

Plans call for four pumping stations

Test your reputation at 1050° F

These Taylor Forge stainless steel return bends were manufactured recently for an extreme high temperature operation in an Eastern power plant. The double-long radius, 6-inch return bends are of Stainless Type 347 steel, in Schedule 160 wall thickness, and are the first of their kind to be made available to the power station field.

This is not the first time Taylor Forge has been identified with unusual "firsts." These fittings are operating at 1050° F temperature and 1500 pounds pressure. Naturally, the manufacture of *safe* fittings for such conditions *demands and gets* complete mastery of forging techniques, which is part of our daily job. That is why more features that count are combined *only* in WeldELLS and other Taylor Forge welding fittings. That is why Taylor Forge welding fittings, available in a wide range of types, sizes and metals, are so universally preferred for the most critical conditions.

WeldELLS *have everything*

They alone combine these features:

- **Seamless** — No question about soundness in a fitting that is forged and formed seamless.
- **Tangents** — Keep weld away from zone of greatest stress — simplify lining up.
- **Precision quarter-marked ends** — Expedite layout; insure accuracy. A constructive refinement.
- **Complete identification**—Permanent type; saves time; prevents errors.
- **Wall thickness never less than specification minimum** — Assures full strength and long service life.
- **Machine tool beveled ends** — Provides *the best* welding surface; accurate bevel and land.
- **Full line**—The most complete line of welding fittings and forged steel flanges in the world—greatest range of types, weights, sizes.

TAYLOR FORGE & PIPE WORKS

General Offices & Works: Chicago 90, Ill. (P. O. Box 485)

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☐ Send your latest data on *Stainless Steel* Welding Fittings and Flanges.

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Mail to Taylor Forge & Pipe Works
P. O. Box 485, Chicago 90, Ill.

New! TERRISS 3-SPEED
PORTABLE MIXER
STIRS • BLENDS
MIXES • AGITATES

No more carrying heavy mixer . . . clamping to tanks . . . breaking side walls

The New TERRISS 3-Speed Portable Mixer is an all-around unit that will take care of all your mixing, blending and agitating problems. If your tank or vat is below floor level the TERRISS 3-Speed Mixer will reach down and do a real job for you. If your container sits on the floor, a little adjustment and the mixing begins. If your tank or container is high off the floor, the TERRISS Mixer will lift up and do the mixing job. All parts that touch your product are Stainless Steel. Standard belt drive permits propeller speeds of 175 RPM, 325 RPM and 575 RPM. Other combinations are available with simple adjustments. Both propeller shaft and stand are adjustable, permitting unlimited settings to fit any job in your plant.

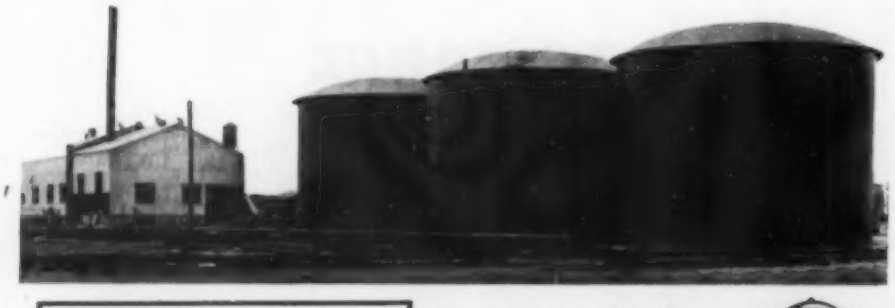
Send your order today . . . money-back guarantee

CONSOLIDATED
SIPHON SUPPLY CO., INC.
Dept. C, 22-24 Wooster St. New York 13, N. Y.

When it comes to
TANKS
Come to
COLE

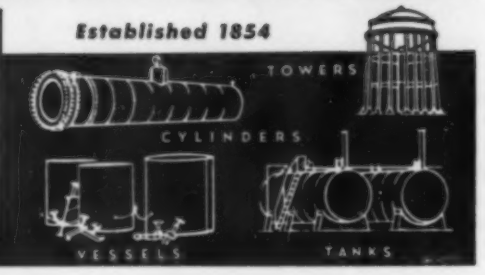
Write for latest Cole catalog—"TANK TALK"

For almost a century the name of "Cole" has meant dependable storage tanks for liquids, chemicals, and gases of all sorts; also elevated tanks, boilers, pressure vessels, stand-pipes, and smoke-stacks. Our large engineering staff is at your service. Write us about your problems. We'll send details and costs. No obligation.



R. D. COLE
MANUFACTURING CO.
NEWNAN, GA.

Established 1854



designed to keep a pressure of 750 psi. Maximum daily delivery capacity would be 290,000,000 cu. ft. minimum, 100,000,000 cu. ft. If the project materializes, construction will begin late in 1949 or 1950. Completion would require about a year. Contracts being negotiated with Alberta producers would require gas reserves to be maintained at 150 percent of the applicant's requirements for a period of 25 years. Natural gas, now unavailable in the Northwest, would mean much to the region's industrial and fuel economy.

Tulsa Gets Grants for New Petroleum Building

WORK on the University of Tulsa's Petroleum Science Building at Tulsa, Okla., has been facilitated by large gifts from Carter Oil Co. and Stanolind Oil & Gas Co., which have contributed $100,000 and $125,000 respectively. Construction of the

CONVENTION CALENDAR

Manufacturing Chemists Association, annual meeting, Skytop, Pa., June 3.

American Coke and Chemicals Institute, Greenbrier Hotel, annual meeting, White Sulphur Springs, June 7-9.

Chemical Market Research Association, annual meeting, New York, June 11.

American Leather Chemists Association, Mt. Washington Hotel, Bretton Woods, N. H., annual meeting, June 16-18.

National Fertilizer Association, annual meeting, White Sulphur Springs, June 21-23.

American Society for Testing Materials, 51st annual meeting, Book-Cadillac Hotel, Detroit, June 21-25.

Western Packaging Exposition, San Francisco Civic Auditorium, San Francisco, August 10-13.

American Chemical Society, 114th national meeting, Washington, August 30-September 3.

American Association for the Advancement of Science, centennial meeting, Washington, September 13-17.

American Institute of Chemical Engineers, regional meeting, French Lick Springs, September 15-17.

Third Instrument Conference and Exhibit, Convention Hall, Philadelphia, September 13-17.

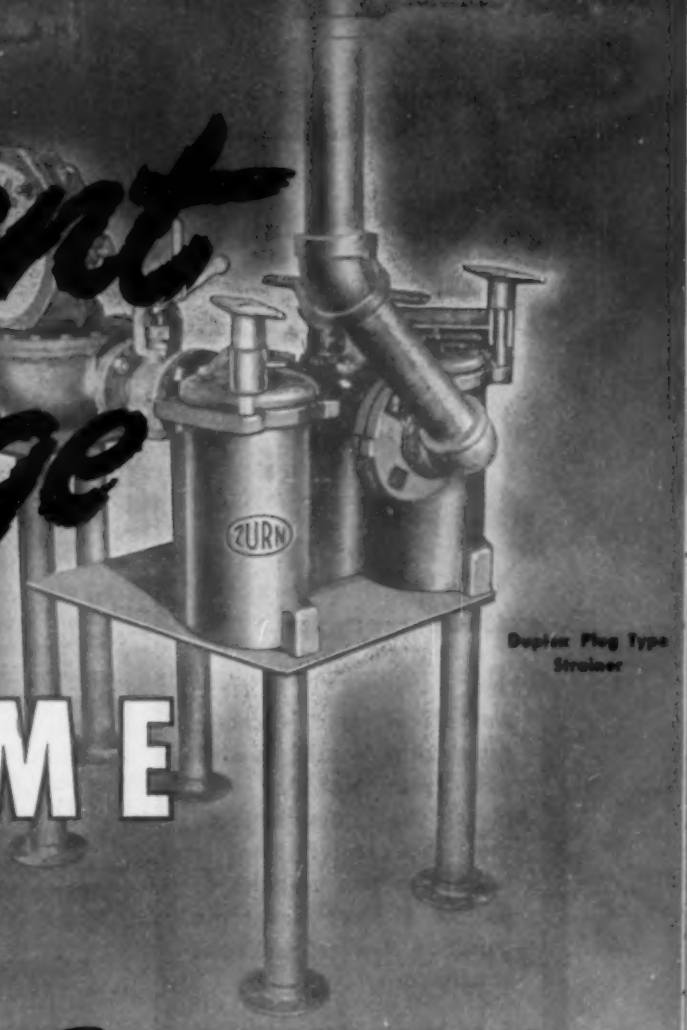
National Plastics Exposition, Grand Central Palace, New York, September 27-October 1.

Sediment Damage

IS MAKING DOWNTIME INEVITABLE WHEREVER

Fluid Handling Equipment*

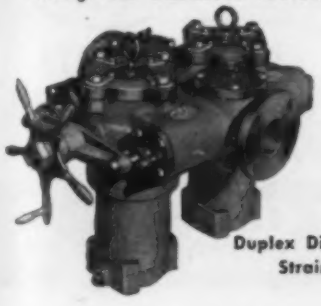
IS IN OPERATION



Duplex Plug Type Strainer

*Fluid Handling Equipment includes all types of Pumps, Valves, Meters, Traps, Regulators, Aspirators, Injectors and other types of control equipment.

Sediment Damage *Downtime* is the effect of uncontrolled sediment! Uncontrolled sediment travels in fluids and remains in the piping system, accumulating at points and within control equipment, eventually and inevitably causing *Downtime*. Sediment Damage is occurring right now—even while you read this message. Its effects are unpredictable! Make-shift methods and practices neither control sediment nor prevent Sediment Damage. The results of a thorough study of this troublesome and costly burden on production are presented in a 24-page booklet especially prepared for top management and plant operating executives. Take the first step in obtaining engineered control of sediment and overcoming *Downtime!* Write for your copy today on business letterhead.



Duplex Disc Type Strainer

ZURN

J. A. ZURN MFG. CO.
Pittsburgh Avenue, Erie, Pa., U. S. A.

Please send me copy of booklet "SEDIMENT DAMAGE MAKES *DOWNTIME* INEVITABLE"

Name ..... *Position* .....

Company .....

Street .....

City ..... *State* .....

48-15

J. A. ZURN MFG. CO. • Industrial Division • Erie, Pa., U. S. A.

SPRAY TROUBLE? Consult MONARCH

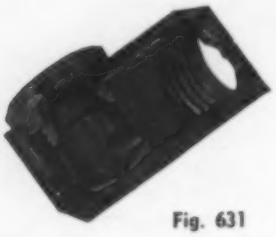


Fig. 631

Are all of your processes using Spray Nozzles as efficient as you think they could be? Do the Sprays distribute the liquid evenly? Break it up into as fine particles as you would like? Resist the corrosion or wear conditions satisfactorily?

Send Monarch an outline of any spray problem—if your liquid can be sprayed with direct pressure at all—Monarch can furnish the nozzles.

NOZZLES FOR:

- ACID CHAMBERS
- AIR WASHING
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- GAS SCRUBBING
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- OIL BURNERS
- SPRAY DRYING

Do you have our Catalogs 6A and 6C?

MONARCH MFG. WORKS, INC.
2513 E. ONTARIO ST.
PHILADELPHIA 34, PA.

Tulsa's petroleum science building will be next to this engineering unit.

$750,000 building will begin some time this year.

Both doners, in announcing their gifts, stressed the benefits received by themselves and the petroleum industry generally through the technological training of students at the university. Both companies have been active for a number of years in the Midcontinent region and have their general offices in Tulsa.

The Petroleum Science Building will be erected west of Phillips Engineering Building, and will be a three-story concrete structure with cut stone facing. The building will house the fundamental sciences taught in the College of Petroleum Sciences and Engineering. A portion of the floor space will be devoted to research laboratory equipment.

Chemical Engineers Hold Cleveland Meeting

CLEVELAND was the site of the recent regional meeting of the American Institute of Chemical Engineers. There were 28 papers presented at the technical sessions. Among the symposiums were those on chemical engineering in the synthetic rubber

BUILT TO TAKE PUNISHMENT IN INTERSTATE TRANSPORTATION

HERCULES *Aero*
(RUBBER CUSHIONED)
CARBOY BOXES

5 GALS.

Specifications:

SIZE 12½"x12½"x17¼" (I.D.)
WEIGHT Approx. 23 lbs. without bottle.
CARBOY 5 gals. or 42 pts.

Available with hinged top in 1, 2, 3 gal. sizes.
Other Carboys available in 6½ and 13 gal. sizes.

COMPLIES WITH CLASSIFICATION I.C.C. 1-A.

HERCULES CORK-CUSHIONED CARBOY BOXES NOW AVAILABLE!

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Simplify Your Tubing Jobs

...bring them all to B&W

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SEAMLESS
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for ANY Service

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Finding the right pressure tubing—Seamless or Welded—for any refinery application is a simple problem when your requirements are put up to B&W. The variety of tubing made by B&W embraces the widest range of analyses available from one source.

So no matter what kind you need—from plain carbon to high alloy tubes including a full range of ferritic and austenitic stainless steel grades—B&W makes it . . . for any combination of operating conditions from the ordinary to the severest with respect to corrosion, oxidation, creep strength, high or low temperatures . . . for any application in chemical and other processing plants . . . for vital parts of processing equipment.

Ask for full information on all or any type of B&W Tubes.

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Seamless and Welded Tubular Products in a full range of Carbon, Alloy, and Stainless Steels for All Pressure and Mechanical Applications.

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Advantages of Lateral Ventilation

1. **CONSERVES HEAT** by pulling in and exhausting unheated air
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Send now for this FREE, comprehensive treatise. Contains selection, performance and application data for Bifurcator fans in lateral ventilation of tanks for standard 2-sided tank exhaust, rear manifold exhaust and jet "push-pull" systems. 36 pages. 10 charts provide graphic solutions for duct design and equipment selection.

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Please send me, without obligation, your new book, "Lateral Ventilation of Tanks."

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program, industrial waste, and coal tars developments.

Plant trips included inspections of rayon manufacture, aeronautical research, steel production, ceramics plants, alkali units, and ore handling.

St. Joe Paper Plans New Plant in Houston

ST. JOE PAPER CO. plans to build a $1.5 million paper container manufacturing plant at Houston, Tex., on a 38-acre site purchased in April. The plant will have about 150,000 sq. ft. of floor space and will be designed to convert 3,000 tons per month of liner board into containers. Plans for the project were being drawn last month. Paper will be supplied by the company's mill in Florida.

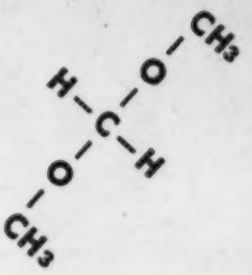
Nevada Plans Large Chemical Center at Henderson

STAGE is being set for things to happen at Henderson, and it appears that they will be chemical. Title to the $140,000,000 former BMI magnesium facilities and townsite has passed to the State of Nevada and is vested in the Colorado River Commission. More and cheaper power will be made available by 1951. Negotiations on favorable freight rates are progressing. Interest by chemical firms in the project is definitely on the up-swing.

Operation of power transmission, sewage and water facilities for the BMI plant and the town of Henderson was taken over by Nevada on April 1, 1948. A letter of intent signed about the middle of March transferred the entire project to the state. Final contract has now been signed and approved by the State Board of Control. Chief provisions of this contract are:

(1) Title to the plant is vested in the Colorado River Commission on payment of one dollar plus the net revenue from lease or sale for 20 years or until $24,000,000 is paid. (2) If revenues are insufficient to maintain the plant, the state may supply the funds or turn the project back to WAA after a 3-month written notice. (3) If WAA receives a bona fide offer from private industry to buy the entire plant before Nevada passes legislation permitting the Colorado River Commission to sell, the state will reconvey to WAA or to the purchaser. (4) Within three years, an arbitration committee will fix the final selling price, which will not exceed $24,000,000. (5) Sale is subject to any outstanding provisions of the National Security clause at the time of final transfer. (6) A main-

CELANESE* METHYLAL



New Low-Cost, Versatile Chemical Commercially Available

LOW COST. Celanese Methylal is competitive with other low cost organics including acetone, methanol, isopropanol, and other commonly used materials.

VERSATILE. ***Extractant.*** Superior to diethyl ether in a number of respects, methylal combines better solvent properties, negligible peroxide buildup, ease of recovery, low toxicity, and high stability at neutral or alkaline pH to insure its use as an extractant.

Reaction Medium. The broad solubility characteristics of methylal have created wide interest in its application as a reaction medium. These favorable characteristics are so diverse as to include heavy metal salts, caustic, and acetylene among the many compounds within its solubility range.

Resin Solvent. Combining excellent solvency for cellulose nitrate, ethyl cellulose and other natural and synthetic resins, with a fast evaporation rate, methylal possesses tailor-made qualities for specific solvent applications.

Chemical Intermediate. Methylal reacts with various amino-, hydroxy-, and similar active groups to form a controlled, anhydrous source of formaldehyde and methanol.

Specialty Fuel. Used alone or as an octane-booster for aviation gasoline, methylal is currently proving its superiority over methanol, diethyl ether, benzene, and other high-powered fuels and fuel additives in the field of specialty fuels.

COMMERCIALLY AVAILABLE. Methylal is produced in tank car quantities by Celanese, through the oxidation of abundant natural gases at its Chemcel plant, Bishop, Texas.

For further information on properties and uses, including working samples, write to

CELANESE CORPORATION OF AMERICA
Chemical Division, 180 Madison Avenue,
New York 16, N. Y.

A NEW TYPE

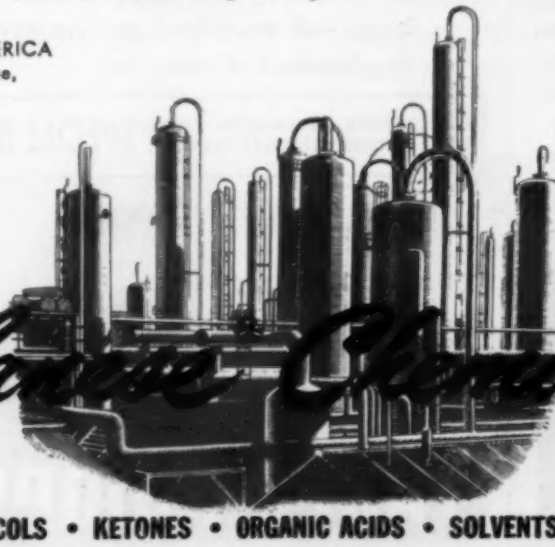
GLYCOL

2-METHYL-1, 3-PENTANEDIOL

combining solvent, lubricating and penetrating properties.

Containing one primary and one secondary hydroxyl group, Celanese* Methyl Pentanediol is miscible with most common organic solvents and is completely soluble in water. These characteristics, together with a compatibility for certain coating and ink resins, plus unique viscosity and hygroscopicity and a high boiling point (215°), give to this compound a combination of properties not found in any glycol now in use.

Call on Celanese for technical assistance and information regarding the application of methyl pentanediol in your field.



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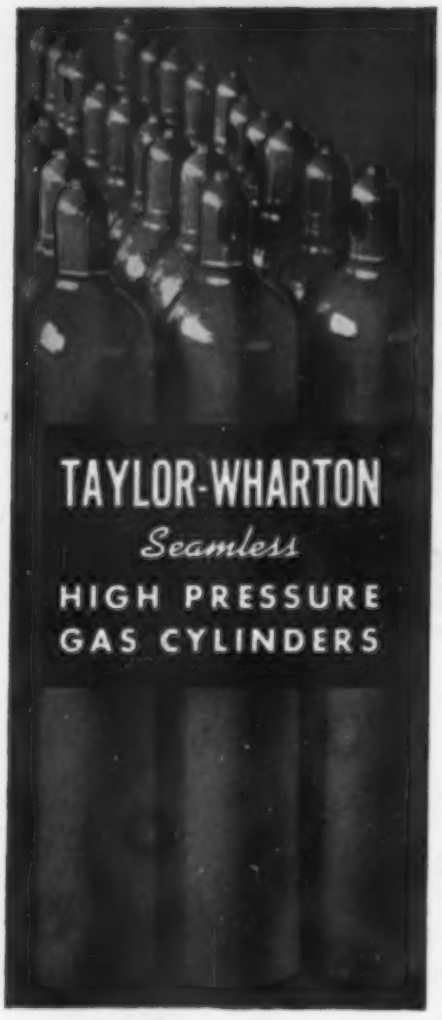

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Seamless
HIGH PRESSURE
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Prompt service on your needs for

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Diameters up to 13"

• All Taylor-Wharton cylinders are made by the reliable "billet" process to the highest standards of manufacturing, testing and inspecting. Bottoms are integral (not spun), wall thicknesses are carefully controlled for uniformity. Complete, modern facilities to meet all your needs as to quantity, types and sizes. Let us quote on your requirements.

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Washington, New Jersey, U. S. A.

Three new 59-oven batteries of coke ovens at National Tube Co.'s Lorain Works have forced an expansion of byproduct facilities at this plant.

tenance fund of $300,000 will be set up by reserving $75,000 annually from payments to WAA; this agency must approve payments from the fund. (7) The Bureau of Reclamation may negotiate to acquire the entire power transmission system. (8) After long-term power is assured for the plant occupants, the state will offer the entire facilities for sale. (9) WAA will transfer to Nevada its rights to the use of generator G-7 at Hoover

RATINGS THAT ASSURE
TABER PUMP PERFORMANCE

In the processing industries, Taber "general use" Centrifugal Pumps prove superior to trade pumps.

Features which indicate their extreme flexibility and dependability, are a variety of impeller combinations for given-size casings; casings of various sizes for given-size yokes; over-size ball bearings; extra size shafts; extra deep stuffing boxes—all assembled and conservatively rated for the final requirements of *your* job.

FOR COMPLETE INFORMATION, PLEASE WRITE ON YOUR LETTERHEAD FOR TABER **SPECIAL BULLETIN CL-339** 5429

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TABER PUMPS for Higher Practical Performance

...proves tops for this job

A sizzling 300°F. to a chilly 45°F.—that's the temperature range of the various conveyor bearings on the brazing oven and cooler illustrated above. Yet Stanobar Grease is used on all 350 bearings in the unit.

This grease has a high melting point, so that on the hot bearings it resists thinning out and does not separate. At the same time Stanobar maintains a smooth, workable consistency on the cool bearings. As a result, all bearings are protected against wear, dirt and moisture at all times.

Stanobar Grease can reduce lubricating cost on the many anti-friction bearings in motors and machines in your plant. Two grades are available, for application either by grease gun or through central lubricating systems. Ask for the services of the Standard Oil Lubrication Engineer in your midwest locality. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANOBAR GREASE

STANDARD OIL COMPANY (INDIANA) STANDARD

3 ways Transite Pressure Pipe reduces water line costs

1. Installation

QUICKLY ASSEMBLED: Transite's Simplex Coupling means fast assembly. Perfect joints are quickly, easily made even by inexperienced crews—and each joint can be checked for proper assembly as the pipe is laid.

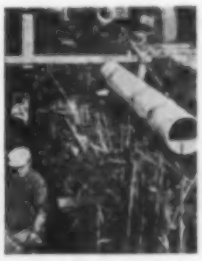
EASILY HANDLED: From unloading to final installation in the trench, Transite's light weight means easy handling. Most sizes can be handled without mechanical equipment. And, more footage can be carried per truckload.

DEFLECTIONS: Deflections up to 5 degrees at each joint are possible in Transite water lines. Flexible Simplex Couplings permit laying pipe around curves and obstructions without special fittings.

2. Operation

MAXIMUM FLOW—LOWER PUMPING COSTS: The smooth interior of Transite Pressure Pipe assures minimum friction loss, maximum flow. And because Transite is made of asbestos and cement, it cannot tuberculate and lose its high flow capacity. Pumping costs, as a result, stay low.

3. Maintenance



RESISTS CORROSION: Installations in cinder fills, salt marshes, etc., prove Transite's high corrosion resistance. Furthermore, Transite Pipe cannot rust . . . cannot cause "red water."

WITHSTANDS VIBRATION: A Transite line is protected by Simplex Couplings . . . each a flexible "link" that helps the line absorb stresses and vibration—safeguards against costly leakage.

For additional facts about Transite Pressure Pipe, including engineering data, write Johns-Manville, Box 290, New York 16, N.Y.

Johns-Manville
TRANSITE PRESSURE PIPE
for Water Supply Lines • for Fire Lines • for Process Lines

dam after expiration of the present agreement allowing Southern California Edison to use this generator.

Under the Colorado River Pact, Nevada is entitled to 18 percent of the entire Hoover dam output of power. Nevada's present generator has a capacity of only 82,500 kw., this is considerably less than its allowance. The state can get more power by installing a second generator or by blending Davis dam power with that from Hoover. According to one report, there is an excellent chance that the state will get 60,000 kw. from Davis. Governor Pittman and other Nevada officials have already acted to insure ample low-cost electric energy to the project by mid-1951. John V. Mueller of the Colorado River Commission, Reno, has been appointed general manager of the project.

The 38 lessees now in the plant occupy about 20 percent of the available space, according to Mueller. Largest are Stauffer Chemical Co., Western Electrochemical Co., Amecco Chemicals, Inc., and U. S. Vanadium Corp. (see *Chem. Eng.*, Dec. 1947, pp. 132-135). At least three major chemical firms are showing considerable interest in the plant. It is becoming evident that Nevada intends to encourage development of the facilities into a major and integrated chemical manufacturing center.

Among other assets of the area are: plenty of cheap water, power that will be more abundant and cheaper by 1951, low-cost chlorine, favorable tax structure, such chemicals as caustic soda, hydrogen and muriatic acid, proximity to such raw materials as salt, soda ash, potash, high-grade limestone, silica sand, dolomite, gypsum, salt cake and coal, proximity to the industrial and agricultural markets of southern California and the Southwest. Freight rates with Union Pacific are expected to be adjusted more favorably.

Shell to Cancel CIO Contract At Emeryville Laboratories

INTENTIONS of cancelling its contract with the United Office & Professional Workers of America, CIO, Local 225, effective June 4, 1948, have been announced by Shell Development Co., San Francisco. Workers affected are employed at the company's Emeryville, Calif., laboratories. Failure of the union's local and international officers to file non-communist affidavits was given as cause for the action by T. W. Evans, laboratory manager.

It was stated, however, that if non-communist affidavits are filed be-

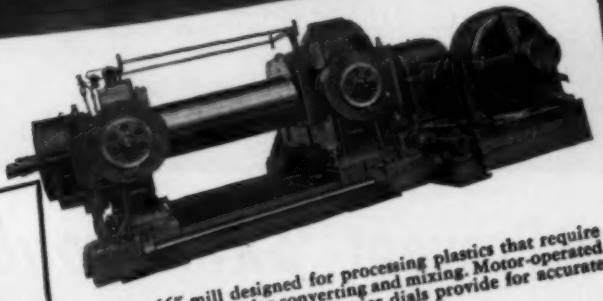
HERE'S WHAT WE MEAN BY "DESIGNED-FOR-THE-JOB" MILLS

Before making recommendations of a mill for processing plastics we ask each purchaser just what he wants his new mill to accomplish. What type of plastic is to be processed? What is the output required? How accurate must the gauge be? How about temperature? And so on.

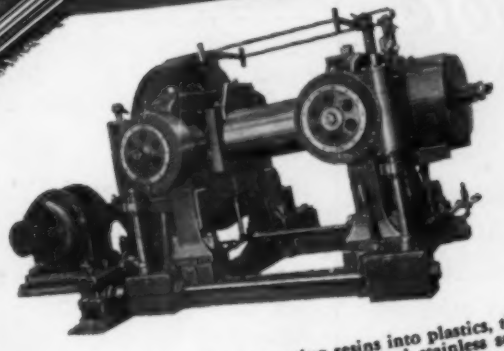
When we have the answers to these questions we are in a position to build a machine that will suit the user's individual needs exactly. The mill supplied may be a standard machine, a modification of standard, or possibly a new design, depending on the job to be done.

Designed-for-the-job mills are available in a complete range of sizes, from 8" x 16" for the laboratory up to 28" x 84" or 100" heavy duty mills for the factory. Write for complete information.

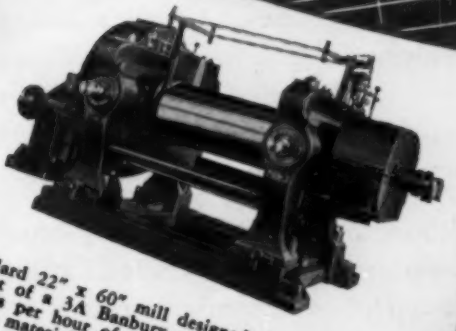
8" x 16" laboratory mill with geared motor drive enclosed in a high base of welded construction. Compact arrangement conserves floor space and provides ready access to the mill from all sides.



24" x 66" mill designed for processing plastics that require high temperature for converting and mixing. Motor-operated roll adjustment and large vernier dials provide for accurate maintenance of gauge during operation.



Designed specifically for converting resins into plastics, this 18" x 42" mill has chrome-plated rolls and stainless steel adjustable guides. The full bronze-lined journal boxes are flood lubricated and fitted with improved oil seals.



Standard 22" x 60" mill designed to handle the full output of a 3A Banbury mixer; approximately 1200 pounds per hour of textile coatings, plastic film and similar materials.

F-B PRODUCTION UNITS

Banbury Mixers · Plasticators · Pelletizers · Mixing, Grinding, Warming, and Sheeting Mills · Bale Cutters · Tubing Machines · Refiners · Crackers · Washers · Calenders · Hose Machines · Hydraulic Presses and other equipment for processing rubber and plastic materials.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

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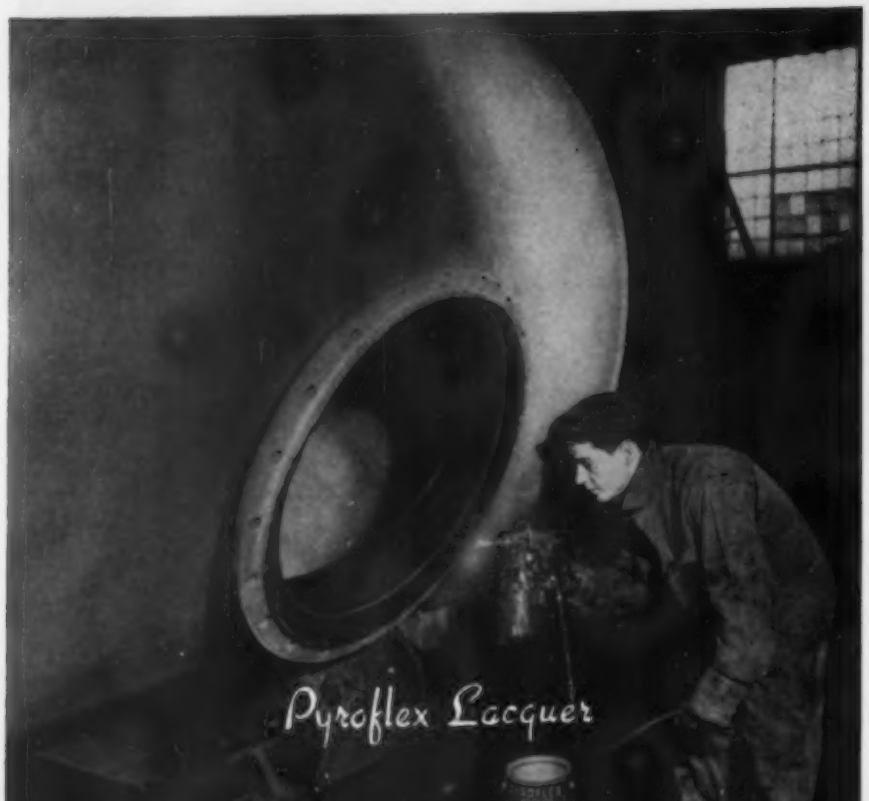
FB-402



How to Prevent *'Skin Trouble'*

(on Tanks and Metal-Work)

Frequent costly maintenance, and even failures, can result where metal exteriors are not adequately protected from corrosive fumes. A tank's lining may be 100% corrosion-proof while its shell is afflicted with corrosive 'skin trouble'! Pyroflex Lacquer protects your tanks and metal-work with a tough surface coating that will withstand severe corrosive conditions.

Although it can be applied by brush or spray gun it is not an ordinary paint. Pyroflex Lacquer is an improved formulation of inert synthetic resins. It is impervious to acid, alkalies, oils, grease, alcohols, water and a variety of other corrosive agents.

Pyroflex Lacquer may be applied to metal, concrete, wood or previously painted surfaces, no primer coat is required. It is available in colors: gray, clear, red, yellow, green, black, aluminum and white, and is shipped in one-, five- and fifty-gallon containers.

Maurice A. Knight 105 Kelly Ave., Akron 6, Ohio
Acid and Alkali-proof Chemical Equipment

fore June 4, the company will withdraw cancellation notice. Similar action has been taken by Shell Oil Co., Inc., in its contract with Local 236 of the same union, which represents a group of employees at its Martinez, Calif., refinery.

Firm Plans to Make Plywood From California Redwoods

COMMERCIAL production of redwood plywood will start early next year at a mill now under construction by M & M Wood Working Co., at Eureka, Calif. The $1,500,000 plant will be the first large unit of its kind to use redwood, states Thomas Malarkey, vice president and general manager. Extensive experiments have proved the soundness of the idea, he added. Annual capacity will be more than 54,000,000 sq. ft. of softwood plywood. The plant will be on property leased from Hammond Lumber Co.

M & M is already one of the major producers of Douglas fir plywood and is the country's largest manufacture of fir stock doors. Plants are operated at Longview Wash., Albany, Ore., and Portland. The firm produces phenolic resins and other adhesives at Portland for use in its own mills. Its Albany unit has the only high-frequency electrostatic gluing installation in the Northwest softwood plywood industry. M & M net sales have increased 500 percent in value since 1939.

Magnolia Refinery Will Start Operations Soon

MAGNOLIA PETROLEUM CO., will put into operation this year at its refinery at Beaumont, Tex., the first of a group of new pilot plants which will assist in carrying forward the company's postwar modernization and expansion program. The units will be housed in a process control building that is already under construction.

Among the pilot plants to be operated in this building is a plant similar to the Thermofor catalytic cracking unit in the refinery. Also to be constructed are pilot plants for single solvent refining and for refining by the Duo-Sol process, which Magnolia uses on a commercial scale. Miscellaneous fractionating equipment will be among the facilities planned for the extensive pilot plant program.

V. A. Kalichevsky, consulting chemical engineer at the Beaumont refinery, will have general supervision of the work, which will cover on a small scale most of the company's refining processes and make possible an ex-

Character Reference for Electrical Equipment

No pump—for gasoline or other volatile fluids—can deliver finer service than is built into its motor. This explains the assurance that the Leland name plate brings. Seeing it, you know that the equipment manufacturer has gone the limit in providing long, safe, trouble-free life for his product. Leland has produced *more* gasoline dispensing pump motors than all other motor manufacturers combined—yet since Leland produced the *first* one with Underwriters' listing only 3/10 of 1% of this great number have ever required factory service! This dependability characterizes Leland motors of all types. *Look for Leland Motors always—for a guide to good equipment.*

LELAND EXPLOSION-PROOF MOTORS

FOR USE IN ATMOSPHERES containing gasoline, common petroleum, ethyl and methyl alcohol, acetone, and lacquer solvent vapors. (*Underwriters' Listing—Class 1, Group D*).

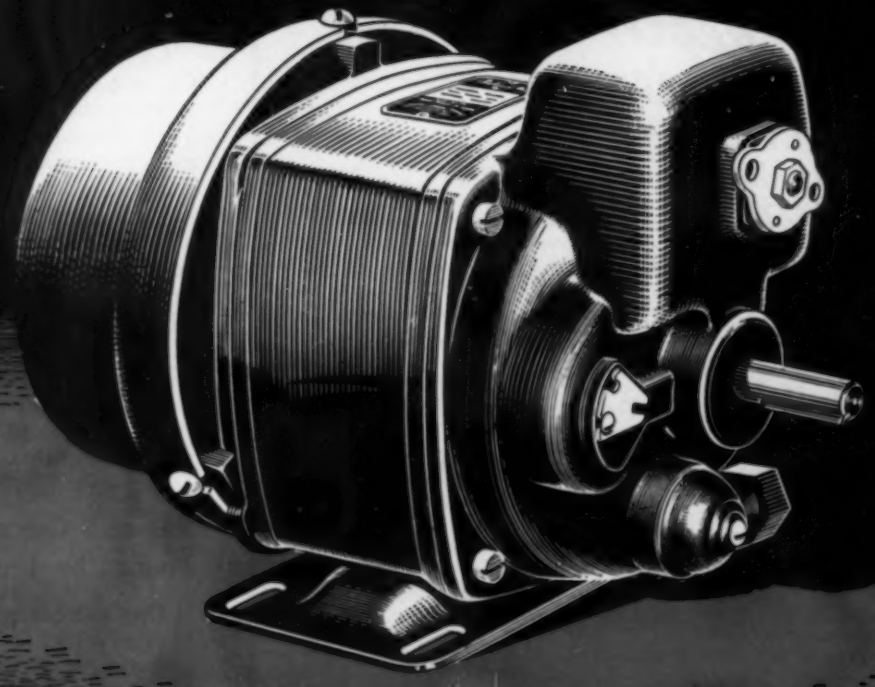
TYPES: Single Phase (Repulsion start, Induction-run and Repulsion Induction); Polyphase; Direct Current.

SIZES: 1/6 to 5 HP.

THE LELAND ELECTRIC COMPANY, DAYTON 1, OHIO
and LELAND ELECTRIC CANADA, Ltd., GUELPH, ONTARIO

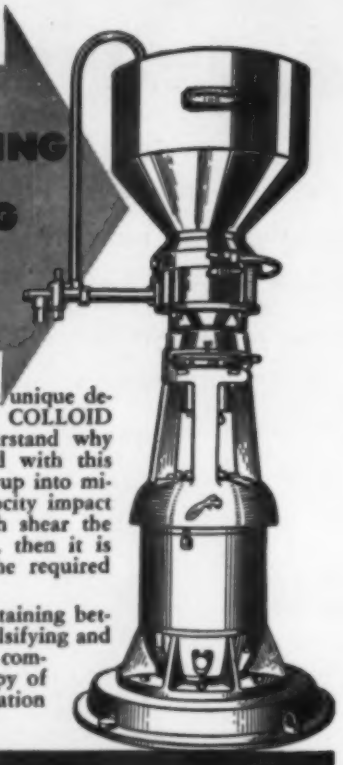
Representatives in all principal cities

LELAND
EXPLOSION-PROOF
MOTORS
Motors of all types—engineered to industry's specific needs



Leland Type RA (Repulsion Start, Induction Run) Continuous Duty Explosion-Proof Motor.

FOR *Better*
HOMOGENIZING
EMULSIFYING
GRINDING



When you examine the unique design of an EPPENBACH COLLOID MILL, it is easy to understand why finer diffusion is obtained with this machine. Liquid is broken up into minute globules by high velocity impact . . . rotor and stator teeth shear the material mechanically . . . then it is hydraulically sheared to the required particle size.

If you are interested in obtaining better results in grinding, emulsifying and homogenizing, write for complete details. Ask for a copy of Catalog No. 401. No obligation of course.

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Processing Equipment for Over 30 Years
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GENERAL INDUSTRY
CHEMICAL & PROCESSING
MINING
OIL FIELDS
POWER PLANTS

Wherever piping dependability is a MUST...

CATAWISSA VALVES ARE THE ENGINEER'S PREFERRED CHOICE FOR TROUBLE-FREE SERVICE, MINIMUM MAINTENANCE COSTS!

LOOK AT THE ECONOMY HERE!

Eliminate the usual additional union and nipple on either outlet or inlet end of the line!

Double Extra Heavy Hot Forged Steel SWING CHECK VALVES

Pipe union type, especially adapted for high temperatures, extreme high pressure service, corrosive and acid conditions. Designed for perfect freedom of movement, with 100% opening. Stainless steel flapper and assembly, forged steel integral seat.

Recommended for . . .
600-lbs. Working Steam Pressure
1500-lbs. Oil, Water or Gas
Tested to 4000-lbs. HSHP

write for your copy of Bulletin 10-A

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100 Mill St. • CATAWISSA, PA.

HOT FORGED STEEL STAINLESS STEEL
UNIONS

tensive investigation of operating variables and raw materials.

The process control building will probably be completed early this fall. The central section of the brick structure will be three stories high in order to accommodate the towers of some of the equipment. In addition to housing the pilot plants the building will have sections devoted to control laboratories, light oil treating laboratories and analytical distillation, testing and filtering devices. In rooms given to wax control studies, temperatures can be maintained at any point between 80 deg. F. and −20 deg. F. A "hot room" where temperatures up to 180 deg. F. can be produced will be constructed.

Magnolia officials, commenting on the purposes to which the new building will be devoted, point out seven main objectives: (1) Establishment of optimum processing conditions to secure maximum refining yields, (2) investigation of possible mechanical changes to bring about production economies, (3) development of processing methods for new crudes, (4) determination of the most economical sequence of refinery operations, (5) determination of the types and characteristics of products that can be made from present crude supplies, (6) evaluation of processes that could be applied to the Beaumont refinery, (7) instruction of process engineers and others dealing with refinery operation.

Phillips May Erect Houston Ammonium Sulphate Plant

OFFICIALS of Phillips Petroleum Co. are considering building an ammonium sulphate plant near Houston. Final decision, said company spokesmen last month, depends largely on the outcome of the company's bid for a lease on the Cactus Ordnance Works at Etter Tex., where Emergency Export Corp. was manufacturing ammonia prior to the recent fire. The company owns a tract of several hundred acres on the Houston Ship Channel. A number of Phillips officials passed through Houston in April in the course of an inspection tour of the company's Texas plants.

Research Committee Named by Truman

ONE more step toward coordination of the scientific research in various government departments was taken by President Truman in the naming of the long-promised Interdepartmental Committee on Research and Development. This group is to be headed

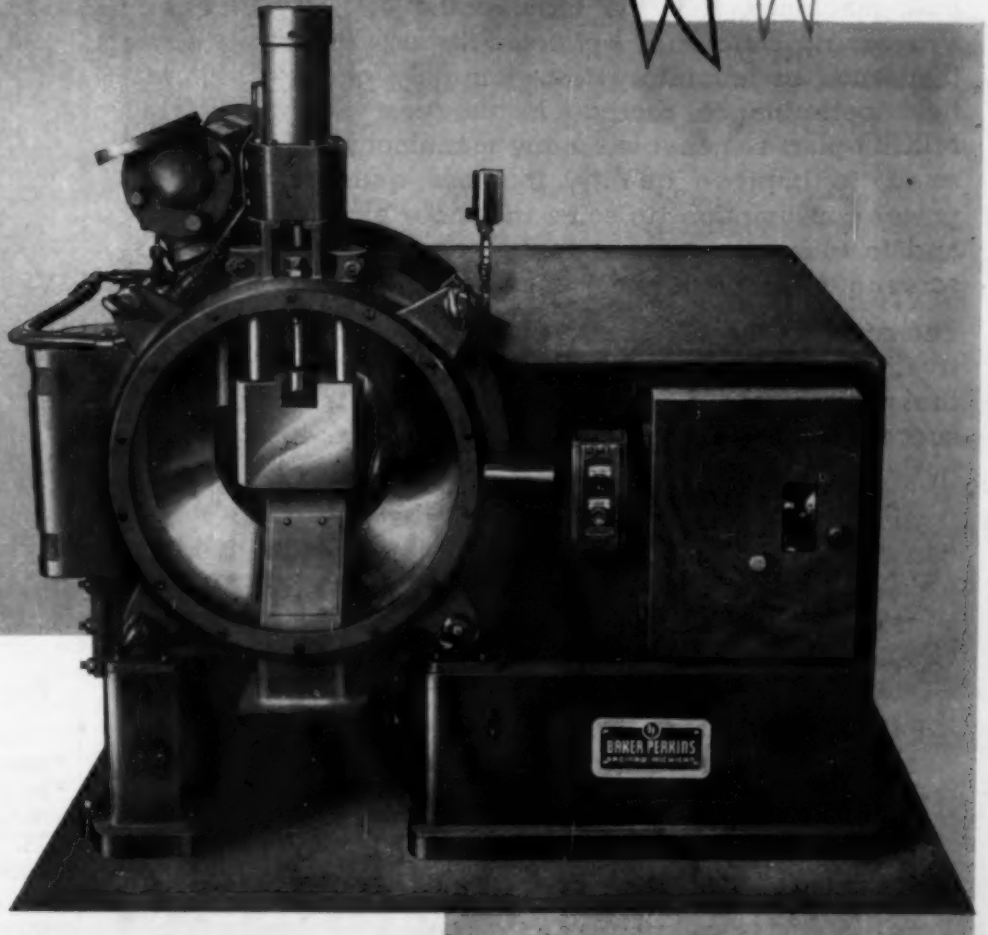
Announcing

THE NEW BAKER PERKINS TER MEER CENTRIFUGAL FOR PILOT PLANT AND LOW PRODUCTION

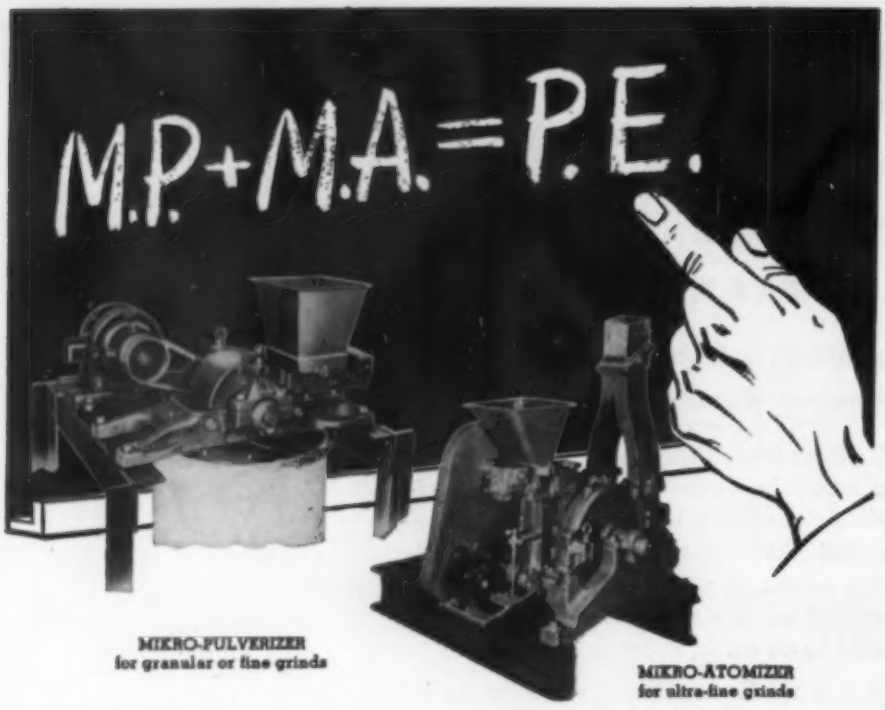
Completely Automatic, Small Capacity, Continuous Running

The new Baker Perkins H-18 ter Meer Centrifugal enables you to centrifuge a wide range of materials *in small quantities for experimental work or limited production.* The basket has a capacity of 0.5 cu. ft. and can be operated on cycles of from 30 seconds to 30 minutes, depending on the nature of the product being centrifuged. Free draining crystalline material frequently can be handled at a rate of from 20 to 40 cu. ft. of solids per hour.

An important feature of this small continuous ter Meer is its wide range of retention time, *making it adaptable to many types of filterable materials.* Totally enclosed, vapor-tight construction prevents escape of solvents. Easily sterilized. Standard models are constructed of stainless steel, special models made of suitable metal to meet particular requirements. *Write for complete information* about this and other models.



BAKER PERKINS INC., CHEMICAL MACHINERY DIV., SAGINAW, MICHIGAN



The above equation has a dollars-and-cents bearing on your production problems. It means that MIKRO-PULVERIZERS, plus MIKRO-ATOMIZERS equal Processing Efficiency.

But the equation involves more than a series of custom-built machines. It is the basis of the **MIKRO-Plan for Processing Efficiency** perfected through thousands upon thousands of laboratory tests minutely checked against field performance records in the past 25 years. The MIKRO-plan has enabled many manufacturers, large and small, to improve quality, increase quantity, decrease power consumption (in some instances as much as 75%) and to eliminate such cost and time-consuming items as screening and classifying, duct work, etc.

The scope of the MIKRO-plan is almost as broad as Industry itself . . . embracing both wet and dry milling. But the proof of its plus efficiency lies in its conspicuous success in handling products requiring ultra-fineness and perfect dispersion of particles.

It will cost you nothing to find out what the MIKRO-plan can do for you. Our research engineers, after preliminary tests, will tell you frankly if it applies in your case. Just write for your copy of our Confidential Test Grinding Data Sheet.

25 YEARS SERVING INDUSTRY

PULVERIZING MACHINERY COMPANY
55 CHATHAM ROAD • SUMMIT, N. J.

MIKRO-PULVERIZER (FINE)
MIKRO-ATOMIZER (ULTRA FINE)
Reg. U. S. Pat. Off.
Also Makers of the MIKRO-COLLECTOR

by Dr. Alexander Wetmore, secretary of the Smithsonian Institution. Vice-chairman is Dr. Thomas B. Nolan, assistant director of the U. S. Geological Survey.

The balance of the board is made up of one representative each from Atomic Energy Commission, National Bureau of Standards, Federal Security Agency, National Advisory Committee for Aeronautics, Department of Agriculture, Veterans' Administration, Department of the Army, Department of the Air Force, Department of the Navy, and National Military Establishment. The President has announced the duties of the Committee as follows:

"The Committee will recommend to the President, and to the heads of the Federal agencies concerned, steps to make research and development programs most effective in the promotion of the natural welfare. Among the specific assignments of the Committee will be a study of changes in the administrative policies and procedures to increase the efficiency of the Federal research and development programs. The Committee has also been asked to report upon current policies and administrative practices relating to Federal support for research such as grants and contracts for basic research."

Fertilizer Research Programs Will Be Coordinated

FERTILIZER researchers of the Department of Agriculture and the state experiment stations got together last month to coordinate their fertilizer research programs and eliminate some of the overlapping and duplication. They'll also try to thrash out the question of what research should be done at the national level by the soil and fertilizer scientists at the Department of Agriculture's Beltsville station, and what research is better done locally or regionally.

Four state research men will serve on each of the four regional committees. These in turn have elected a representative on the 10-man national committee.

Air Transportation Permitted For Flammable Liquids

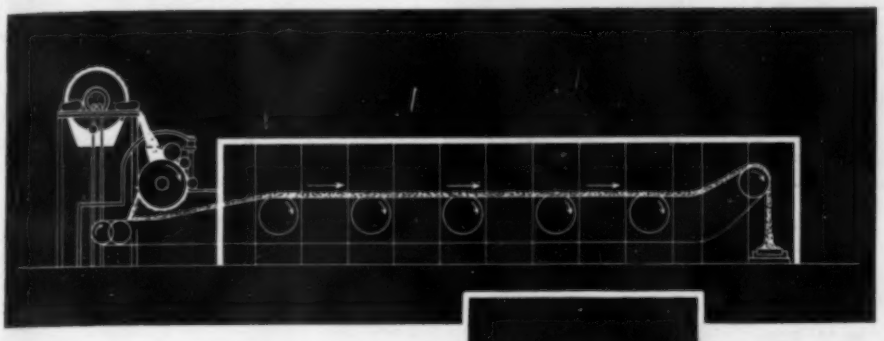
SPECIFIED flammable liquids in small quantity may now be shipped by air, following amendment of Civil Air Regulations announced February 28. The amended Section 49.2 now reads as follows, under the heading "Acceptable explosives and other dangerous articles" which may be carried safely in air commerce:

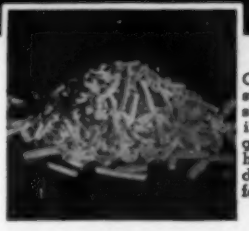
"(c) Samples of aviation grade gas-

CAL Drying DA 2

PUBLISHED MONTHLY FOR PROCESS INDUSTRIES EXECUTIVES AND OPERATING PERSONNEL

TONNAGE OUTPUT OF CERTAIN WET-SOLIDS MADE POSSIBLE BY PROCTOR CONTINUOUS CONVEYOR DRYING SYSTEM WITH "FIN DRUM" FEED





Close up of "fin drum sticks" shows uniform shapes made by pressing wet-solid into grooves of internally heated, revolving drum of the fin drum feed.

In order to make possible tonnage output of wet-solids and still maintain a consistently high quality, Proctor engineers developed the idea of first preforming the product into small, uniform shapes and then drying these shapes in a continuous conveyor system. Because of the physical characteristics of certain wet-solids it soon became apparent that a variety of types of "preforming" feeds would have to be designed. Certain wet-solids reach the feed of the dryer in such a moist condition that it is impossible for the product to hold any definite shape without further moisture reduction. For products of this type—the fin drum feed was developed and has been used with marked success in many installations. When this system is employed the material to be dried is deposited into the hopper of the feed and by means of a "pasting roll" is pressed into the grooved surface of an internally heated revolving drum, where it is partially dried. It is discharged from this drum—onto the conveyor of the dryer—in the form of small sticks of about 1/4" thickness.

Once the preforming is accomplished—it is possible to continue with conveyor drying, whereby heated air is circulated through the bed of material on the constantly moving conveyor of the dryer. Drying the product in the form of small shapes permits heated air to penetrate all the way through to the center of each particle. More rapid diffusion takes place and the drying is subsequently more rapid and still uniform.

The table below lists four products currently being produced in this type of Proctor equipment.

If you have a wet-solid drying problem—Proctor engineers will consider it without obligation. This, or one of the other basic continuous systems, may be your answer. Thorough investigation will tell. In the meantime, if you'd like to know more about Proctor continuous conveyor drying for wet-solids, write for either or both of the books listed below.

Products Preformed by Fin Drum Feed—Dried in Proctor Continuous System

MATERIAL	PRELIMINARY EQUIPMENT	METHOD OF PREFORMING	MOISTURE CONTENT AT BEGINNING OF CYCLE (B.D.W.B.*)	DRYING TIME	MOISTURE CONTENT AT END OF CYCLE (B.D.W.B.*)	HOURLY CAPACITY (C.D.W.†)
Calcium carbonate	Continuous filter	Fin drum sticks	122%	32 min.	0.25%	2750 lbs.
White lead	Continuous filter	Fin drum sticks	69.3%	114 min.	0.075%	1500 lbs.
Magnesium carbonate	Continuous filter	Fin drum sticks	565%‡	29 min.	1.0%	500 lbs.
Lead arsenate	Continuous centrifuge	Fin drum sticks	58.5%	71 min.	0.5%	1000 lbs.

‡This means 5.65 lbs. of water per 1.0 lb. dry material *Bone Dry Weight Basis †Commercial Dry Weight

BOOKLETS TELL STORY OF CONTINUOUS CONVEYOR DRYING

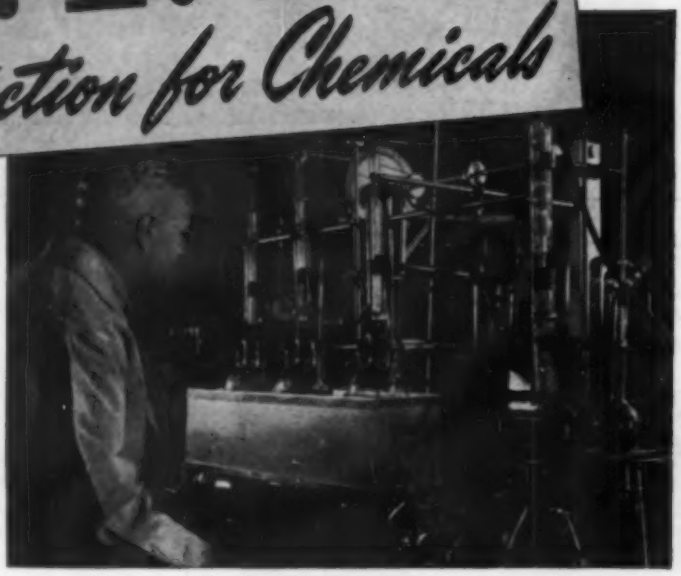
Case histories of 11 installations of Proctor continuous conveyor dryers combined with preforming feeds. Complete details on how systems apply to 11 different products.

Lucid explanation of the principle of "preforming" and continuous conveyor drying, as particularly applied to the chemical process industries.

PROCTOR & SCHWARTZ, INC. • 711 TABOR ROAD • PHILADELPHIA 20, PA.

T.F.P.*

Protection for Chemicals



Laboratory at the Chicago plant where Steri-Seald Linings for many chemical products have been developed.

. . . WITH *Steri Seald* LINED

INLAND STEEL CONTAINERS

Lever locking ring drum—easy to open and reseal air tight.

Our laboratory has developed many interior coatings for steel containers that enable us to offer to the chemical industry a perfect container for many, difficult to pack, chemicals.

Our Steri-Seald lining laboratory is available to help you solve the problem of packaging your chemical products.

***Trouble Free Packaging**

Lever locking ring pail—can be re-sealed, tight.

New Per-Pail lug cover with pouring spout—ideal for liquids.

No. 8 Lug cover pail.

INLAND STEEL CONTAINER CO.

Container Specialists

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oline and oil and samples of inflammable liquids having a flash point of not less than 20 deg. F., excluding carbon bisulphide, ethyl chloride, ethylene oxide, nickel carbonyl, spirits of nitroglycerine, and zinc ethyl. . . ." Detailed specifications for containers and packaging are also included in this amendment, printed on page 1087 of the February 28 Federal Register.

Crosby Building Pilot Plant In Louisiana

CROSBY CHEMICALS, INC., is building a large pilot plant at its steam distilled wood naval stores plant near De Ridder, La. This will be used in conjunction with the company's research laboratory completed late in 1946. The pilot plant is being built to enable the company to carry recently developed products and processes from the research laboratory to large-scale production, as well as to experiment with products in current plant production.

Survey of Mineral Resources Under Way in Oklahoma

A SURVEY of the mineral resources of 47 counties in Oklahoma served by the Public Service Co. of Oklahoma is being made for the purposes of exploring more extensively than in the past the magnitude and quality of minerals and ascertaining the feasibility of establishing manufacturing plants to utilize such products. The project is being financed by the Oklahoma utility company.

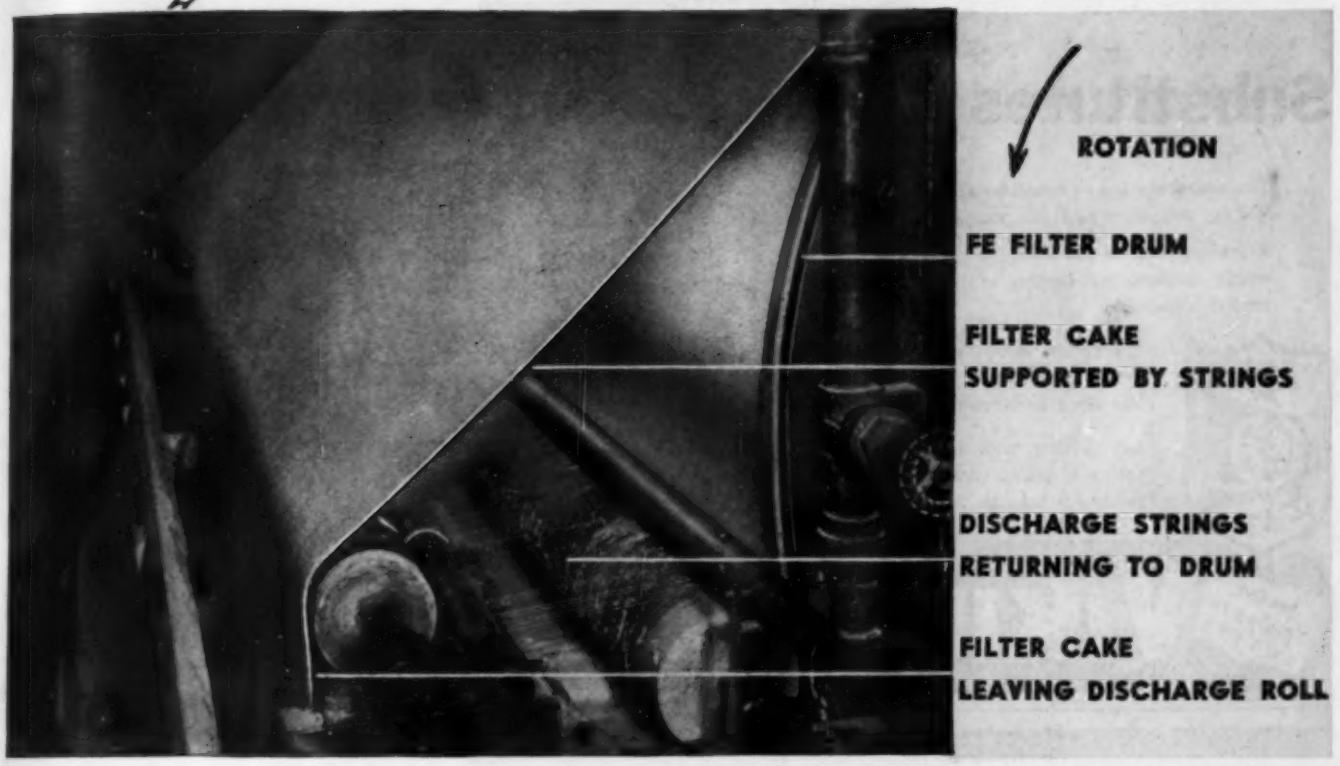
A justification for the survey, according to W. B. Mather, economic geologist for the Midwest Research Institute, is that the state Geological Survey has been handicapped by insufficient funds. Mather points out that a comparison of mineral production and appropriations for Geological Survey in 1945 in three states shows that the appropriations in Missouri, Illinois and Oklahoma were, respectively, $168,000, $500,000 and $50,000. In the same states the values of the mineral production were $74 million, $332 million and $283 million.

Negotiated Contracts for Government Research

FIVE of the military agencies of the government are now able under a new law to arrange negotiated research contracts. This legislation went through Congress, and was signed by the President in February to take effect on May 19 of this year. The new law permits wide authority for development of research contracts and

Strings—on the FEinc *filter*

. . . THEY MEAN LOWER COSTS



The endless, closely spaced strings that comprise the discharge mechanism of the FEinc "String Filter" actually LIFT the filter cake from the drum in one continuous sheet ready for economical processing. Here's how it saves in hundreds of applications:

Cakes as thin as 1/16 in. with no limitation on thickness ranging from "impossible" slimes to matty, fibrous cakes are handled with outstanding success. Permits lighter, more efficient filter cloths and makes them last longer without blinding or scraping wear. Saves hours of cloth-changing time.

There's extra economy in other FEinc features, too—Compression Mechanisms that remove 2-6% more moisture—submergence type washing for cleaner cake and higher soluble recovery—Drum Dryer Combinations—Scoring Devices for feeding cake to continuous dryers—all features that can be engineered to your needs at reasonable cost. Write Filtration Engineers for Bulletin 101, or ask for a free test on your slurry.

CAN YOU USE OUR NEW PILOT PLANT FILTER?

The new FEinc pilot plant filter, for small or temporary production filtering operations, is extremely flexible in application and can handle almost any rotary filtration operation. Equipped with the FEinc String Discharge and Washing mechanisms, the new filter is stainless steel with 10 sq. ft. drum area.

The FEinc pilot plant filter may be rented or purchased. Write for complete details.

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In Canada: The Northern Foundry & Machine Co., Ltd., Sault Ste. Marie, Ontario

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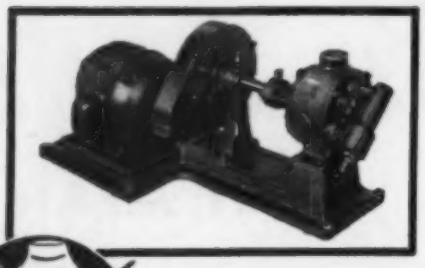


Substitutes ...OUT!

The substitute era of war-time shortages is drawing to a close. Once again Viking, the pump built *for* your job, is becoming more readily available.

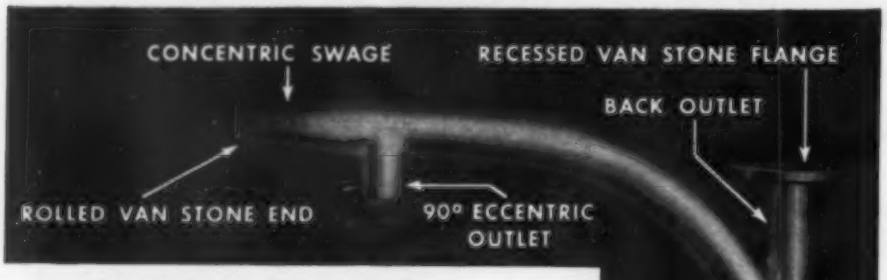
A few are still on the shortage list. However, every effort is being made to vastly increase production of these models. The result is progressively earlier schedules.

Production is up—away up—higher than at any time in the company's record. But please don't forget, quality, at no time, has been sacrificed for higher production.

Buy Viking with assurance of the same dependable "gear within a gear" quality. First in the rotary pump field. Write today for free bulletin 47SC.

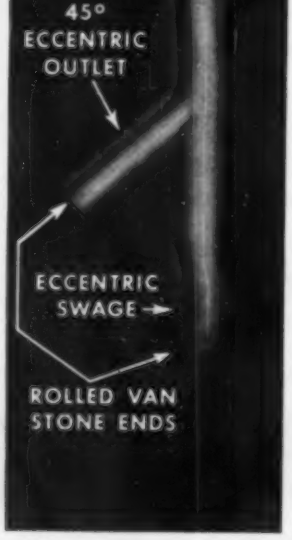
See Our Catalog In SWEETS

Viking PUMP COMPANY
Cedar Falls, Iowa



Stainless Steel Piping Engineered And Pre-Fabricated

Fifteen years ago, we pioneered in developing methods for welding and shop pre-fabrication of stainless steel piping for one of the world's largest food canning companies. We've gained much experience since, and today, we use the latest "inert-gas-shielded-arc" welding, which has only been available for commercial use since the war. The illustration gives some idea of "what-we-can-do" in stainless. Insides of welds and joints can be made absolutely smooth. Our experience in power and process piping dates back forty-eight years and today most utilities and large industrial plants know the perfection of our patented Westport Welded Joint and other high pressure, high temperature pipe engineering and pre-fabrication. Write us, or send us prints for an estimate.



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PIPING FABRICATORS AND CONTRACTORS

the procurement of research material and services by negotiation. It is evident that Congress intends to entrust to the heads of the agencies greater latitude in their programs than before allowed in peacetime government work.

The new authority is available for Department of the Army, Department of the Navy, Department of the Air Force, United States Coast Guard, and National Advisory Committee for Aeronautics. Since these five agencies also can farm out much of their work with such other government bureaus as the National Bureau of Standards, it means that a considerable part of other Federal technical work may now be put on a business basis much more like that of ordinary corporations.

Pure Helium Made By Mines Bureau

HELIUM which is 99.8 percent pure is being made by the U. S. Bureau of Mines at its Texas helium plant.

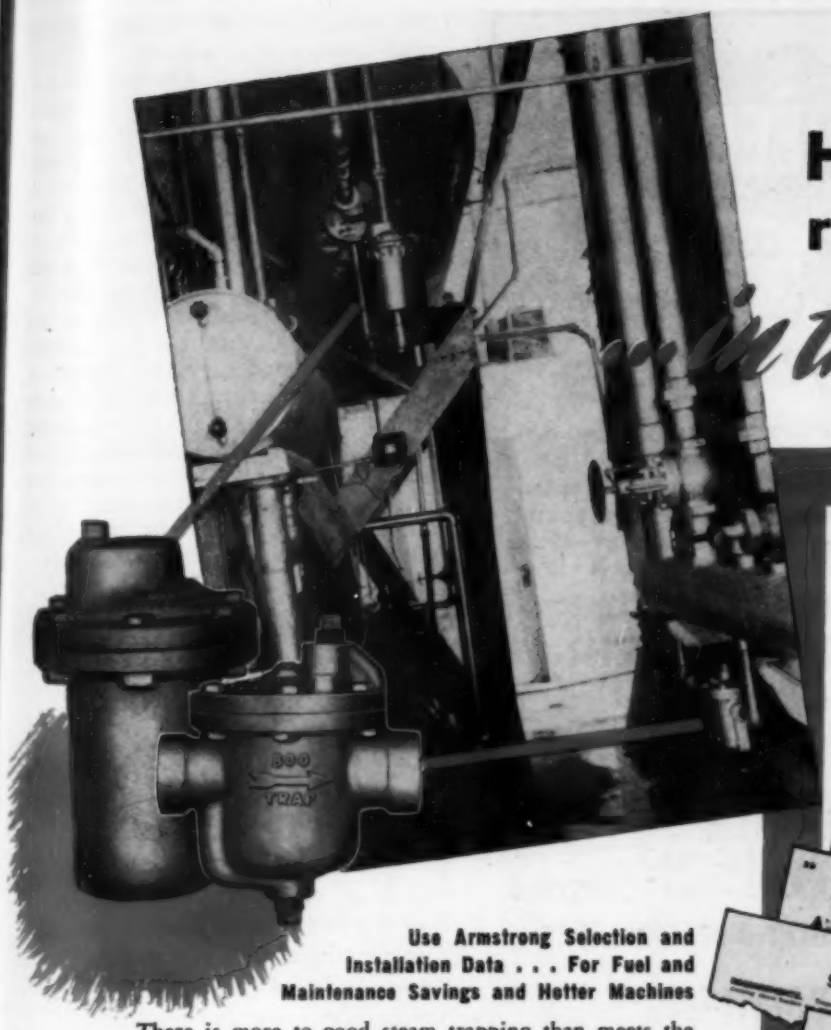
Former production, even during the war period, met military needs at 98.2 percent purity. But that gas had a lifting power about two percent less than the more pure product of today. The new high-purity gas is also of substantial advantage as "welding grade helium," which is now extensively used in the shielded-arc welding process.

The final step in purification, which has made this new gas possible, is adsorption of both nitrogen and hydrogen on activated charcoal at low temperature. Very little helium is taken up on the adsorbent. But the heavier gases are retained at low temperature permitting the last step of purification to go on very simply.

Graduate Training Planned In Atomic Energy Field

A GRADUATE engineering practice school will be established in July at Oak Ridge, Tenn., by Massachusetts Institute of Technology. It will provide varied plant experience to fit men for work in the atomic energy field. Production plants of the AEC operated by the Carbide & Carbon Chemicals Corp. will be utilized in this training. Plans for the school were recently completed by officials of the AEC and Carbide. The latter was represented by Dr. George T. Felbeck, vice president in charge at Oak Ridge; and Clark E. Center, general superintendent of the atomic units. These include the gaseous diffusion plant, electromagnetic plant and the Oak Ridge National Laboratory.

Concurring in the arrangements for



How to get the right steam trap ...in the right place!

The ARMSTRONG Steam Trap BOOK
How to Use the Capacity Chart
Traps for Steam Purifiers and Separators
Steam Main Drainage
Low Pressure Heating Service
Traps for Draining Unit Heaters
Submerged Coils and Tubes
Syphon Drained Cylinders
Installation and Maintenance of Armstrong Traps

Use Armstrong Selection and Installation Data . . . For Fuel and Maintenance Savings and Better Machines

There is more to good steam trapping than meets the eye. For example, intelligent trap selection involves not only the normal condensate load but must take into account peak load and the amount of air to be handled as well. The Armstrong Steam Trap Book tells how to figure condensate loads, what to do about large amounts of air and how to determine trap capacity needed for various services. It follows up with actual hot-condensate capacities of Armstrong traps. (Some trap capacity figures are based on cold water ratings, misleading because any trap will handle more cold water than it will hot condensate).

Then, because a properly selected trap won't function efficiently if it is not correctly installed, The Armstrong Steam Trap Book provides complete data on installation practice. But, even the Steam Trap Book can't think of *everything*, so the Armstrong factory and trained sales representatives stand ready to give you a lift on the really tough trapping problems.

These are a few of the reasons why Armstrong traps can be sold on a basis of "COMPLETE SATISFACTION OR YOUR MONEY BACK."

Send for a copy of the Steam Trap Book and plan now to modernize your condensate drainage system with Armstrong traps.

ARMSTRONG MACHINE WORKS
858 Maple St., Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

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Order a REACTOR and you'll get the outstanding advantages of a special engineered job. This is also true for I★P★E

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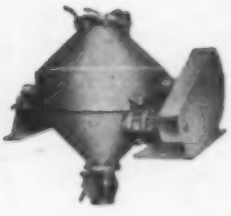
SULFONATORS—CRYSTALLIZERS—
STILLS—DRYERS—ROASTERS—GAS
ABSORBERS—AUTOCLAVES—EVAPORATORS

◀ 2000 GAL. I★P★E AGITATED REACTOR

MIXING EQUIPMENT



—Here's a mixer developed for use with materials having the tendency to lump—a special job that is now "standard-plus." Other I★P★E mixers with outstanding features are

CONTINUOUS MIXERS—PASTE MIXERS—CONICAL DRY MIXERS—DOUGH MIXERS—REDUCING MIXERS.

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—There's an I★P★E agitator for every mixing need—
—TURBINE TYPE—PADDLE TYPE—VERTICAL FINGER TYPE—PROPELLER TYPE—ANCHOR TYPE—RIGHT ANGLE VERTICAL AGITATOR DRIVE.

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the new graduate engineering practice school was the Oak Ridge Institute for Nuclear Studies. This has a broad graduate training program at Oak Ridge in connection with its 14 member universities in the South and Southwest. While the practice school operation will be based on the principles which have been successfully developed in the MIT School of Chemical Engineering Practice during the past 25 years, it will operate as a separate educational unit. It will be open to students from any pertinent branch of engineering. Admission will be restricted to MIT graduate students in engineering who have been in residence at MIT at least one term. The program is open only to United States citizens, cleared by the AEC. Students will be expected to live as a group at Oak Ridge. Term residence will be about five months. The second term will start in February 1949. Academic credit will be given for Oak Ridge work. Since the time spent at the school will be fully devoted to education, students will receive no compensation. They are expected to be assigned by the director to a number of atomic energy problems while at school.

The new school will be in charge of Prof. Walter G. Whitman, head of the MIT department of chemical engineering. Dr. William A. Reed will be the director at Oak Ridge.

Republic Oil Buys Surplus Houston Refinery

REPUBLIC OIL REFINIG CO. has purchased the government-owned aviation gasoline plant which the company operated near Houston, Tex., for the government during the war. The purchase price was $2.3 million. Under the terms of the sale the company is to expend $250,000 in the repair of the plant.

Bibliographies Available On Synthetic Fuels

PROSPECTIVE general interest in synthetic liquid fuels has been strongly emphasized by the demand for literature searches and bibliographies. U. S. Bureau of Mines recognizing the need has started to issue a new series of mimeographed bibliographies called "Synthetic Liquid Fuels Abstracts."

The bureau for its own uses has been studying this literature for about five years. An elaborate bibliography for intra-office use was prepared. This has been released for outside reproduction, which will take the form of a 900-page three-volume set shortly to be issued by Hobart Publishing Co.,

NEW stainless steel RECESSED-END fittings form low-cost, corrosion-resistant conveying lines by—

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TRI-CLOVER RECESSED-END fittings meet the demand for a complete line of low-cost stainless steel units which can be quickly assembled with lightweight tubing to form dependable corrosion-resistant liquid conveying lines. Available in sizes from 1" through 10" O. D., these high-strength fittings require no special installation technique...any one of three standard methods may be used—brazing, soldering or welding, to form permanent or semi-permanent lines. Check the features at the right and you will see why *RECESSED-END* fittings provide the answer to greater protection against corrosion and contamination, at lower installation and maintenance cost.

★ **A COMPLETE LINE**—including Ells, Tees, Crosses, Return Bends, Reducers and Adapters.

★ **STREAMLINED DESIGN**—free flow, friction reduced to a minimum. Less space required. Completely porosity-free.

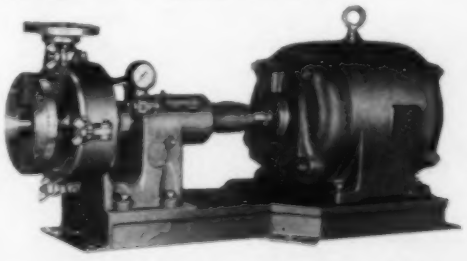
★ **FABRICATED IN 3 TYPES**—available in stainless steel type 304, 347 and 316, to meet wide corrosive conditions.

★ **SAVE UP TO 65% IN MATERIAL**—due to savings in "dead metal" as compared to heavier iron pipe size fittings, yet without loss of strength.

★ **AVAILABLE IN 2 FINISHES**—pickled or polished finish, with any combination of I. D. or O. D. finish required. All fittings fully annealed and passivated.

★ **READILY ADAPTABLE TO OTHER FITTINGS**—through the use of standard adapters, *RECESSED-END* fittings are easily adapted to virtually every other known type of fitting.

NOTE: TRI-CLOVER RECESSED-END fittings meet the special requirements of breweries, distilleries and wineries by providing a sealed joint approved by the Dep't of Internal Revenue.



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Now available in a complete range of sizes and capacities up to 1250 GPM and up to 250 ft. head at Zero GPM. Highest quality corrosion-resistant construction. Fast, non-clogging centrifugal action with special seals for practically every requirement. Endorsed by users throughout chemical-process and allied industries. SEND FOR CATALOG 248.

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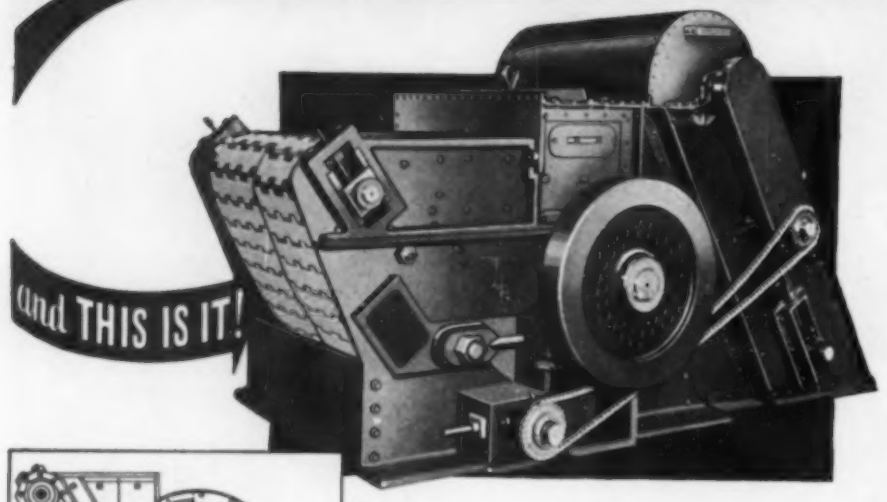

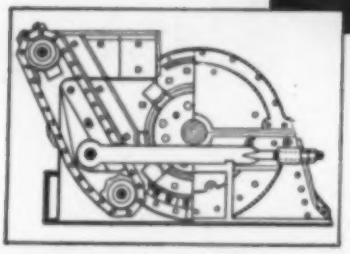

Uniformly high quality of product . . . enormous crushing power . . . lower drying costs . . . result from the Continuously Moving Breaker Plate . . . the patented non-clog feature that accounts for Dixie's greater efficiency. At left—Sectional View of the Dixie Non-Clog Hammermill.

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The Continuously Moving Breaker Plate, the vastly improved non-clog crushing principle developed and perfected by Dixie engineers, has demonstrated its superiority in the reduction of raw materials in hundreds of installations all over the world. There's only one Dixie Hammermill. Don't be misled by claims of "just as good." Make it a Dixie . . . and make sure!

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Washington 15, D. C. Hobart is reproducing this material just as it has a number of the Publication Board documents, which the government offices themselves have neither funds nor personnel to handle officially.

Those wishing the bureau's new series can get on the mailing list by writing to the Washington office explaining their need. The mailing list will be limited to those explaining definite technical requirements because of the limited supply prospectively available. Those wishing to purchase the bibliography index for earlier years, not to be issued by the bureau, can get quotations by mail inquiry to Hobart. The price will be known by May 1.

Gas Reforming Unit Is Started at Riverhead

CATALYTIC reforming of intermediate hydrocarbons into a gas suitable for utility distribution is now a commercial fact at the Riverhead plant of Long Island Lighting Co. Developed by Surface Combustion Corp. of Toledo, this unit culminates an extended program of American Gas Assn. which sought to solve the peak load problems of the city gas business.

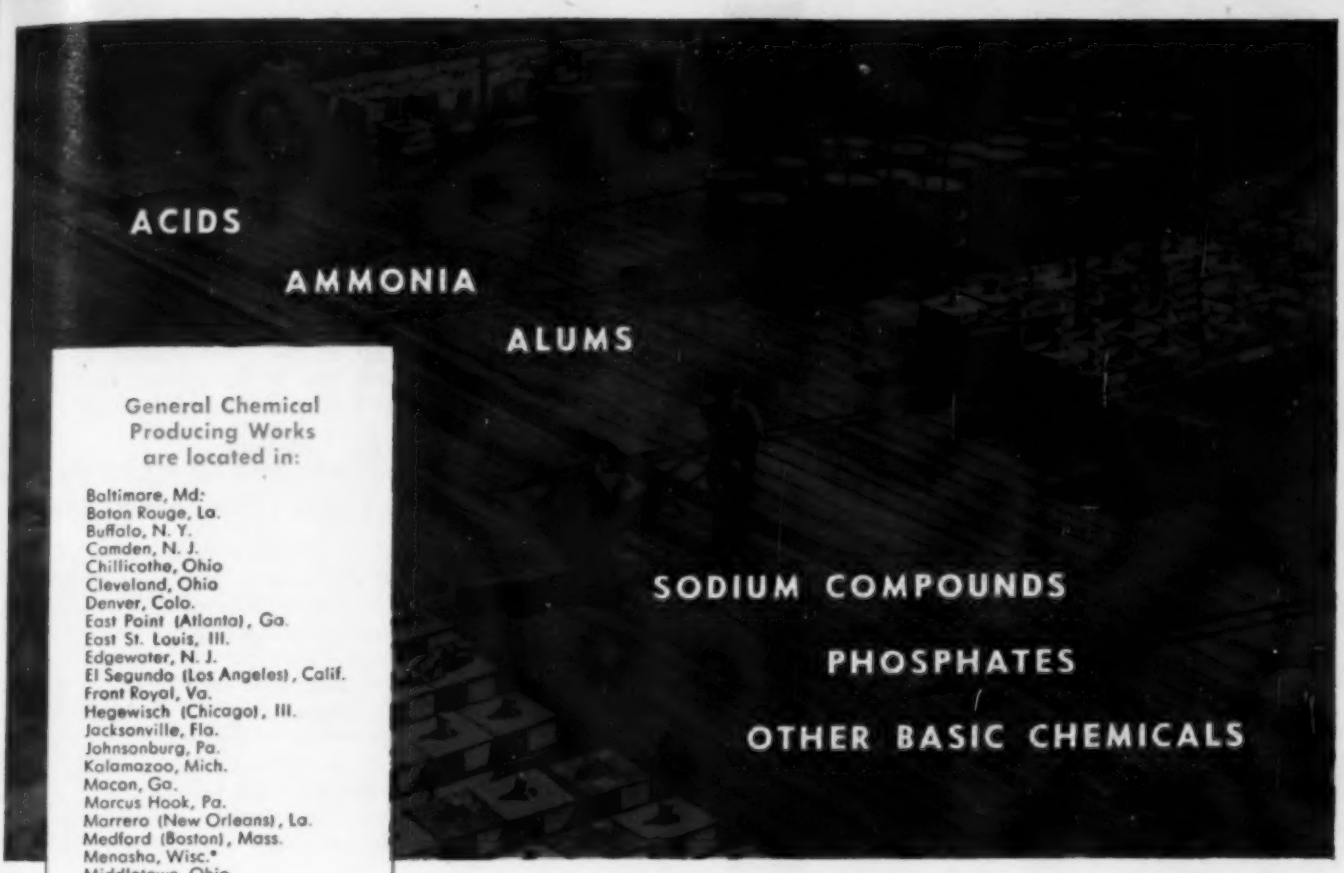
The next big plant contemplated will be built at Harrisburg, Pa., with a rated capacity of 5,000,000 cu. ft. per day. It will make a product similar to water gas though somewhat lighter in density. After development, operating conditions can be so adjusted that this reformed product made from gasoline, propane, or butane will mix well in unlimited amounts with coke oven gas, or in substantial proportions even with heavier water gas.

The Harrisburg layout, including boilers, spherical storage for 420,000 gal. of gasoline and 30,000 gal. of propane and all auxiliary equipment, will cost about $1.25 million.

American Gas Assn. research executives describe the basic process as follows:

The Long Island plant uses heat-resisting alloy tubes filled with a refractory supported catalyst and connected to a system which feeds an automatically proportioned mixture of hydrocarbon vapor, steam and air. Rising through the catlyst bed, this mixture disassociates the vapor into mainly hydrogen and carbon monoxide to form first a blue gas of definite and controlled composition, which at Long Island is gas of 240 Btu. and 0.54 gravity.

The hot gas issuing from the top of the reforming tube is then cooled in primary coolers and a washer cooler



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after which it is automatically cold enriched by the further addition of hydrocarbon vapor to a definite and controlled composition. This cold-enriched gas for the plant is held at 540 Btu. and 0.67 gravity which are the exact characteristics of the gas manufactured by Long Island Lighting Co. at its plants 60 or 70 miles from the catalytic gas reforming plant. Appliances on the entire system can use gas from either the Riverhead catalytic plant or the other straight manufactured gas plants system and obtain the same efficiency and results.

Pan American Enlarging Its Graduate Fellowship Program

PAN AMERICAN REFINING CORP. has increased its previous graduate fellowships in chemical engineering and chemistry to a total of seven for the coming academic year. The company now maintains fellowships in chemical engineering at Rice Institute, Massachusetts Institute of Technology and the Universities of Illinois and Wisconsin, and fellowships in chemistry at the Universities of Texas and Oklahoma and Ohio State University.

Crossett Building Research Laboratory in Arkansas

CROSSETT ARKANSAS INDUSTRIES, Crossett, Ark., has begun construction of a research laboratory to carry out research and development work for Crossett Chemical Co., Crossett Paper Mills and Crossett Lumber Co.

Objectives of the affiliated companies are to find new outlets for wood products, to reduce waste and to improve quality of products. The research plant will contain facilities for chemical analyses physical testing of materials and research in organic chemicals from wood. Pilot plant equipment will be a part of the facilities.

The Austin Co. is in charge of design and construction. K. G. Chesley will be in charge of investigations when the laboratory is completed.

Mississippi Farmers Study Plans for Ammonia Plant

A DRIVE is under way in Mississippi to get sufficient backing among farmers of the state to construct a plant to manufacture 110 tons of ammonium nitrate and 100 tons of anhydrous ammonia per day. The sponsor of the project, the Committee on Nitrogen Plant for Mississippi, is seeking to market 1 million shares of common stock among farmers at $5 per share before it is definitely decided to begin.

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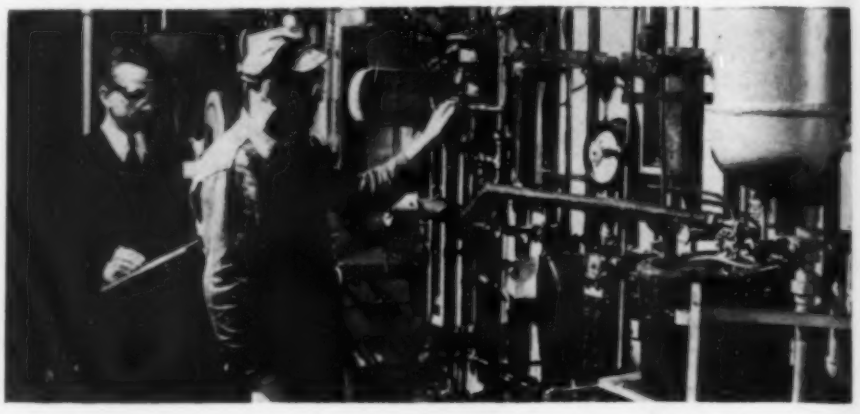
New Research Laboratory

Standard Oil Co. (Indiana) recently dedicated this new research laboratory at Whiting, Ind., in the presence of a host of distinguished chemists and engineers. Below is one of several separate pilot plants in the new unit.



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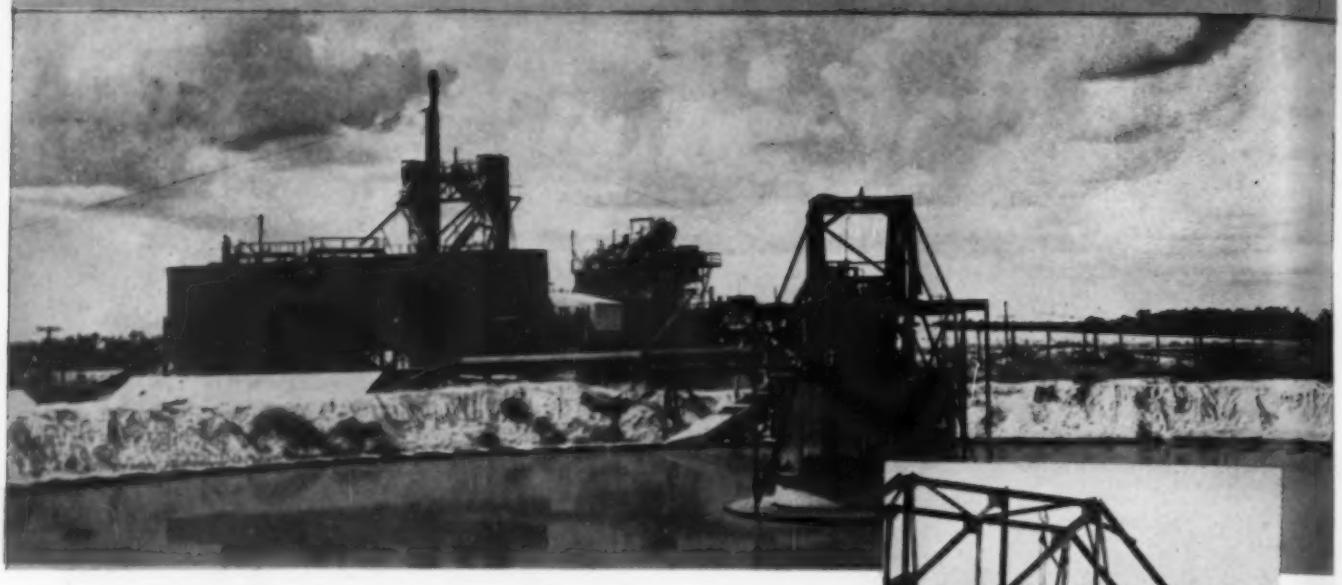

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The arms are never stalled by an overload—the machine is kept in operation while the cause of the congestion is corrected. The actuation of the hydraulic lift can be made entirely automatic.

What's more, your thickener tank can be utilized as a temporary storage tank to absorb tonnage surges, and automatic controls can be supplied for this purpose. This will also permit the storing of feed during week-end or off-shift shut-downs. With the mechanism idle, the hydraulic lift takes care of the start-up as easily as with an empty tank.

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NEWS FROM ABROAD

Special Correspondence

McGRAW-HILL *World News*

Argentina studies plans to expand its linseed oil processing industry and is developing photographic film production . . . India and Pakistan have reached decisions on nationalization policy for several industries . . . Puerto Rico is surveying its oil resources . . . Sydney is using electric heating in process equipment . . . British Columbia expands research activities . . . New delays in British chemical expansion program are result of shortages in construction materials.

Argentina Studies Plans for Linseed Oil Processing

THE Argentine government has decided to study the possibility of utilizing its entire output of oleaginous grains through expansion of its own industry. At the same time, the photographic film industry has been given encouragement to expand by an announcement that all foreign film will be banned to an extent necessary to encourage the local production.

The first announcement carries considerable significance. Argentina has raised the price of linseed oil so high (considerably over OPA prices) that it cannot sell its current crop for dollars. It will now go ahead and manufacture this relative large quantity of oil (about 35,000 tons) into paint, oil cloth, linoleum, etc. This will be a very interesting experiment, and if successful would constitute a complete reversal of Argentina's usual role in the world trade picture.

The photographic announcement declared the manufacture of film and plates for the next five years to be of national interest and authorized the setting of quotas for imports of film and component materials. It was also announced that the year's import quota of calcium carbide would be fixed at 20,500 tons.

India and Pakistan Announce Nationalization Policy

INDIAN and Pakistan governments have decided on definite policies regarding nationalization of various industries. American firms have been following the subject with interest. They will find that these policy announcements take away considerable uncertainty.

Indian industrial policy is to leave the arms, railways, and atomic industries under government control. Existing units in the coal, steel, and petroleum industries will not be considered for nationalization for at least ten years. In the meantime they will be allowed to expand. However, new units will be owned and operated by the government. Chemical, mineral, and machine tool industries will be regulated, but will remain in private hands. Foreign participation in Indian firms must be in the form of a minority holding. However, exceptions will be allowed.

Pakistan has established the following policy. Chemical industry will be 51 percent Pakistani-owned. Exceptions will be permitted. The State owns railways, arms, and ammunition industries. Reasonable returns on investments are promised and there will be no interference with existing foreign setups.

Puerto Rico Looks For New Petroleum Resources

FACED with the need of providing additional fuel to carry on the industrialization program initiated in 1942, the Puerto Rico Industrial Development Co. has contracted the services of United Geophysical Co., Pasadena, Calif., to carry on a study of the possibilities of oil deposits in Puerto Rico. This work is now being conducted by W. H. Myers and a group of technicians, with adequate equipment. The explorations are being made using the socalled seismological system, through which can be calculated the depth of different geological formations, and a map can be traced of the subsoil covered by the explorations.

In Puerto Rico, before the American occupation in 1898, there existed the Spanish law of mines, approved July 6, 1868, which specifically determined that the subsoil of Puerto Rico was the exclusive property of the State. This legal provision was ratified by the insular legislature in 1933, by approval of Act No. 9, of 1933, known as the law of mines, which is still in force. Act No. 243 of 1946, however, gave the Industrial Development Co. of Puerto Rico exclusive rights and powers to develop the oil and mine deposits on the Island; without limitations.

According to W. H. Myers who is supervising oil exploration in Puerto Rico, there are four areas where the subsoil offers the possibilities of oil deposits. These are located on Manati, Toa Baja, Vega Alta, and Arecibo, on the northern coast of the island.

The preliminary studies included preparation of subsoil maps and geological formations. The Development Co. has appropriated $160,000 for this project.

Sydney Using Electric Heating In Chemical Plants

SEVERAL interesting electrical installations in chemical plants are reported by the Sydney County Council's Electricity Undertaking. A novel oil heater has been installed by a Sydney oil firm. It consists of a tubular 50 kw. three-phase, low voltage heating element of stainless steel in the shape of a coil, located in a heat-insulated box. The unit heats 80 gal. of coconut oil per hour from 170 deg. F. to approximately 400 deg. F. Oil flows continuously through the coiled tube element. Temperature of the oil is thermostatically controlled.

A large installation of electrically

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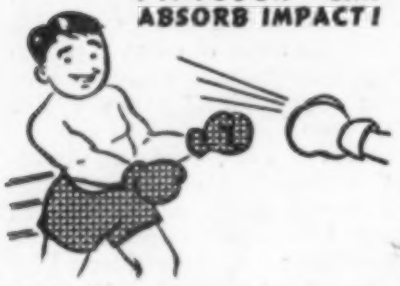

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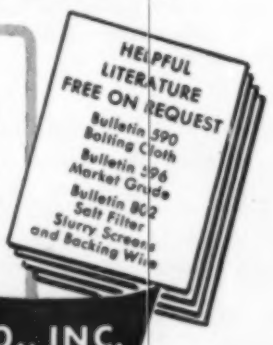
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heated kettles for the treatment of synthetic oils and resins in the manufacture of basic materials for paints and varnishes is nearing completion at another plant. One large kettle holding 15,000 lb. and rated at 200 kw., and two smaller kettles each treating 7,500 lb. per batch and rated 120 kw. have been connected, and additional units are on order. The heating elements are nichrome spirals wound for 240 volts and mounted externally on the sides and under the bases of the kettles. Contractor panels, push-button operated, control the elements in sections to vary the heat input to the kettles to meet the requirements of individual heating cycles. Suitable heat insulation is provided to reduce heat losses to a minimum.

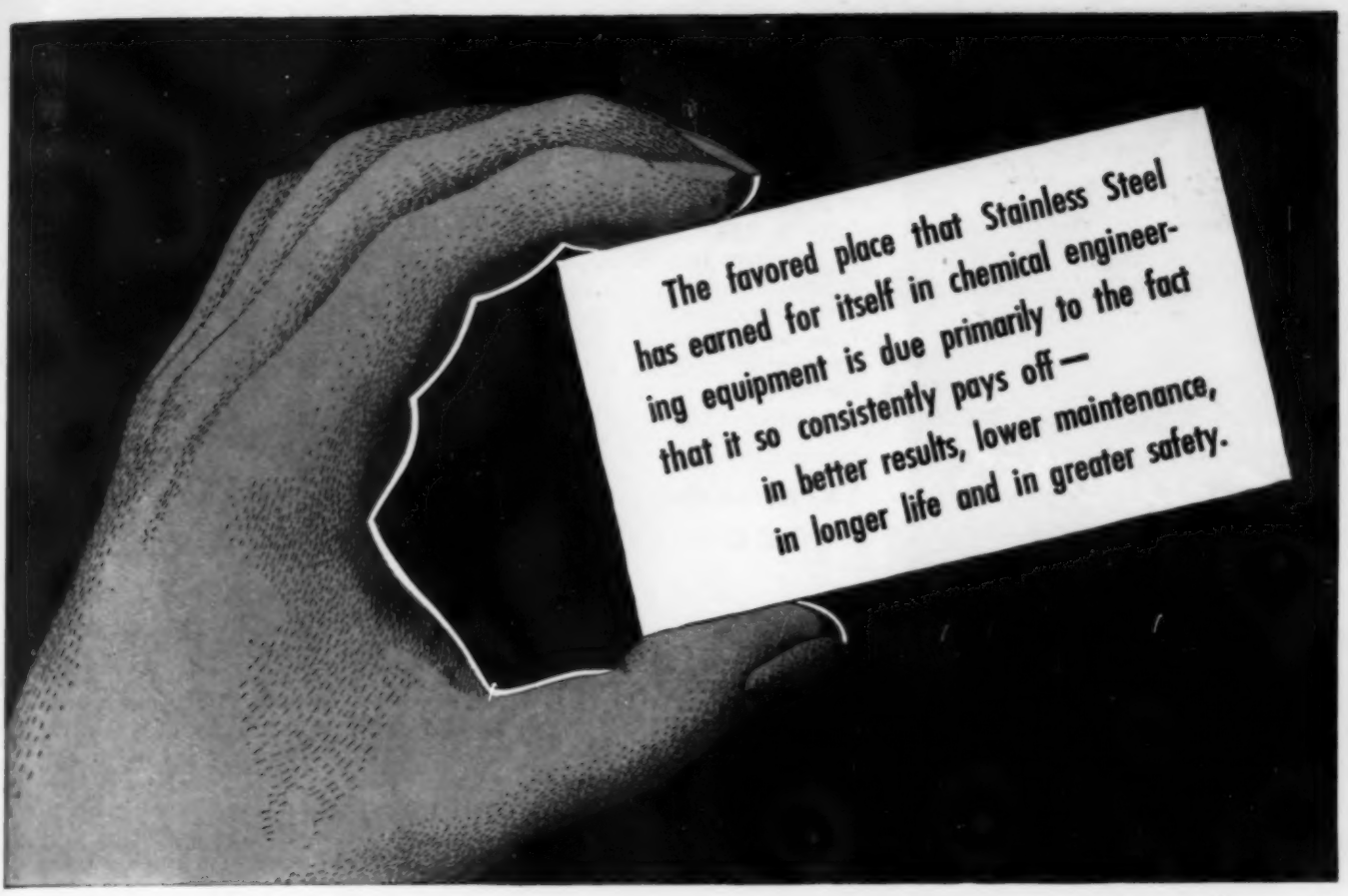
A conveyor-type oven arranged for steam heating during the normal working day and for electric heating at off-peak periods has recently been constructed at a large Sydney paint works. The oven is used for drying white lead from a semi-liquid state, containing 33⅓ percent of water, to powder form. The oven is 65 ft. long, 13 ft. wide and 10 ft. high. It is rated at 360 kw. and is designed for an output of six tons of dry white lead in 24 hours.

British Columbia Expands Research Activities

ENLARGED laboratories, new equipment, a larger and more diversified staff and an increased knowledge of the problems of British Columbia industry will enable the British Columbia Research Council to provide a still more complete industrial research service during 1948.

Establishment of the division of applied biology under Dr. Paul C. Trussell was one of the most important additions to the council's services during the year. The division of engineering has also expanded its facilities since the appointment of Ronald W. Klinck as head of the division. Further additions to the staff, together with reorganization of pilot-mill equipment, have enabled resumption of ore dressing research for the mining industry. The council's experimental foundry is now ready for operation. Extensive additions of new equipment have been made, particularly in the chemical, biological and physical metallurgy laboratories. The council is now prepared to handle problems in the fields of industrial chemistry, physics, applied biology, mining, reduction metallurgy, the foundry and other metal trades, and the major branches of engineering.

The increased importance of research in industrial policy, however,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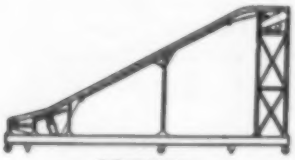

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is best demonstrated by the 50 percent increase in the number of projects initiated. The inquiries handled by the Council's information service increased by a similar percentage over the 1946 figure, to more than four hundred.

Industrially supported research projects in 1947 were larger not only in numbers but in scope. Investigations in the fields of wood products, metal fabrication, food byproducts and fuels were among the most extensive projects initiated for individual firms during the year.

Marton Canada Ltd. has established temporary quarters at 544 Powell St. Vancouver, B. C. It is planning to produce a full line of cosmetics, perfumes and toiletries. Dr. Jules M. Marton, Seattle perfume manufacturer recently brought filling, mixing and filtering machinery from the United States for operation in Vancouver.

The plant is a direct result of the austerity program under which a ban was placed on U. S. toilet articles. The company is planning erection of a $50,000 building in Vancouver as soon as a site has been selected and plans to serve all parts of Canada.

EXPANSION OF BRITISH CHEMICAL INDUSTRY SLOWED BY DELAYS IN GETTING BUILDING MATERIALS

SWIFT enactment of the Foreign Aid Bill has freed the British Government of a serious worry. Without such external assistance British raw material imports would have had to be cut in the second half of 1948. Wholesale unemployment and industrial dislocation would have been the inevitable consequence. With the European Recovery Program in force it will still be difficult to do more than maintain present standards of consumption and employment. But the fear that the domestic economy would have to put up with further cuts in raw material supplies to prevent premature exhaustion of the country's gold and foreign currency reserves has been allayed. The program of the Economic Survey for 1948 will now be regarded as a minimum program, to be amended and improved as the foreign exchange position is eased by American aid.

Rise of prices and costs has reached proportions which threaten to upset

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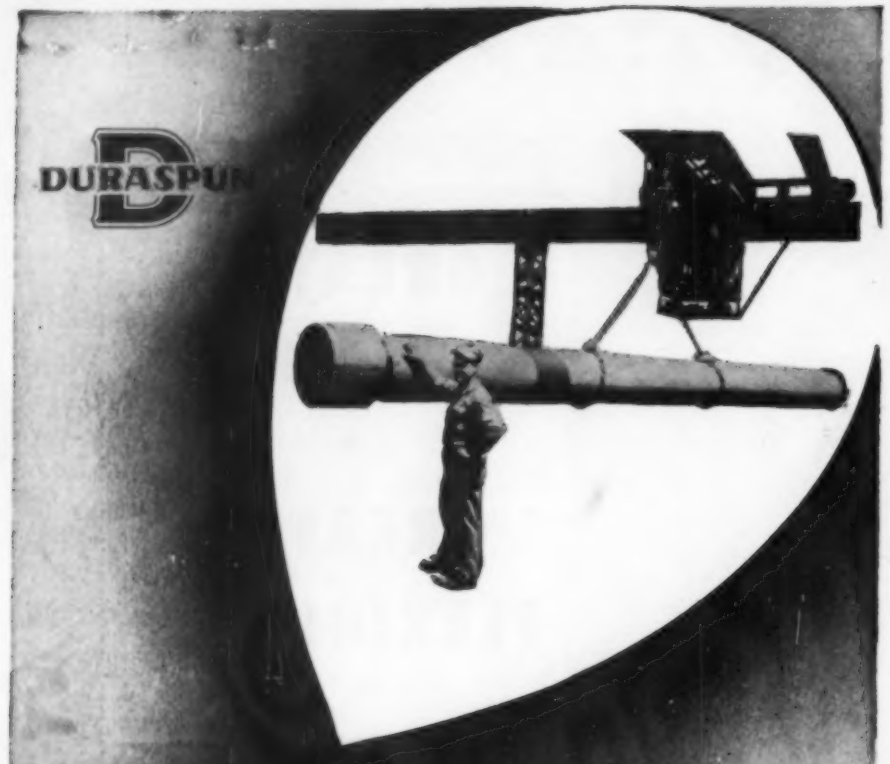

23 FEET of a 19 INCH *Centrifugally* CAST "CARTRIDGE"

It's alloyed to meet a highly corrosive condition. It's centrifugally cast to give it the higher strength and greater metal density to meet a tough structural requirement. It's typical of what we can do in our centrifugal casting department. In this case two sections were made and welded together.

May we suggest that if you have need for any high alloy pipe or tube ranging in diameter from 2½ inches to 24 inches and, depending on diameter, up to 15 feet in length, you look into our centrifugal casting service.

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the whole economic apparatus. The government has therefore decided on a policy of wages and prices stabilization at levels reached around the turn of the year and hopes that wherever possible industry will lower its selling prices. In the chemical industry labor relations have always been very good, and the aim of stable wages should not therefore be opposed if pursued on a nation-wide scale. Most prices are subject to official control and have been raised only when higher raw material costs made it imperative. Some chemical products which are not officially controlled have undergone considerable price changes. However, as the manufactures in question are largely unessential and excessive price advances entail a contraction of demand, they have been increased in price only when special circumstances called for it.

Rising Costs

Producing costs, on the other hand, have risen substantially. Not only are wages, fuel costs, raw material prices, transport charges and other items of current expenditure much higher, but plant replacement, repair and modernization represents a greatly increased charge on production. This factor is frequently ignored by the control authorities when dealing with applications for permission to raise selling prices, on the ground that full-capacity use of existing plant offsets the impact of higher construction and equipment costs on the charge for obsolescence and depreciation per unit of production. If, it is argued, plant and equipment are more expensive now, the manufacturer can nevertheless calculate with the former rates of capital expenditure per unit of production because he is making better use of his plant capacity.

What rates of obsolescence and depreciation are appropriate for chemical plant and apparatus has long been a point of contention between chemical industry and tax authorities. As chemical plant is comparatively short-lived, it must be written off quickly. Many British manufacturers feel that the present prices for chemicals provide no adequate return for plant depreciation, and maintain that the present high rate of plant utilization and the consequent need for earlier replacement support the claim for higher depreciation allowances. As a matter of fact, most firms have raised their allocations to plant reserves from current profits, and at least one leading firm has stated that some of the plant and buildings added last year to meet present demands have cost more than their real value in more normal times.

The rise in cost of new plant and

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New quality detergents in the form that's easiest, most economical for you.

You can get Atlantic's new K series Ultrawets in the form that best suits your processes — flakes, liquid or beads.

Superior wetting, sudsing and detergent properties make these improved alkyl aryl surface-active agents efficient and economical for cleaning compounds, cosmetics and industrial processes. They are immediately available in quantity.

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As a liquid, Ultrawet K's are pale amber in color, and odorless (no kerosene or sludge odor). As flakes and beads, they approach the compounder's ideal of whiteness and lack of odor.

Ultrawet K's are the latest achievement of an organization that has produced quality detergents and wetting agents for over 10 years. Atlantic's great research facilities assure a product of uniform, high efficiency. The physical data:

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Wt. % Active Sulfonate—min.	**85**	**25.5**	**35**

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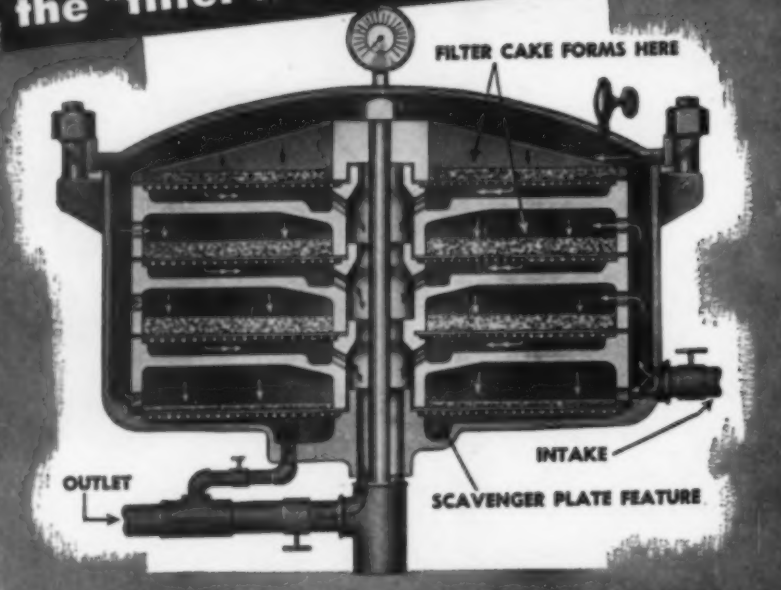

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★ Patented Scavenger Plate permits *complete* batch filtration. (It's virtually an auxilliary filter with an independent control valve.)

★ Unexcelled filter cake stability — no slipping or breaking.

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Because filter media are supported on a horizontal plane and filter aids floated into position uniformly; filtration takes place uniformly over entire filtering areas. Flow through filter is always *with* gravity.

Sparkler Filtration Is *Engineered* Filtration—we invite correspondence on your problem. You will receive the advice of filtration scientists with a quarter of a century of experience in a specific field.

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delay in delivery of chemical machinery have forced many chemical firms which have embarked on expansion schemes to review their calculations. They generally find that they have underrated the capital expenditure involved but often manage to offset the adverse effect of cost increases by incorporating improvements in their delayed plans. Frequently the revised plans provide for larger capacities as practical experience has shown the demand to be greater than anticipated. Delays in the delivery of chemical plant are as irksome as ever. Many of the most important development projects have had to be deferred because the plant required cannot be obtained at present. Official control of new industrial schemes, though intensified because of the shortage of structural steel and engineering products, is not impeding development in the chemical industry as much as was feared, since chemical factories are ranking high on the government's priority list. But the physical limitations in the way of increasing supplies of chemical plant are quite definite and being felt by all expanding companies.

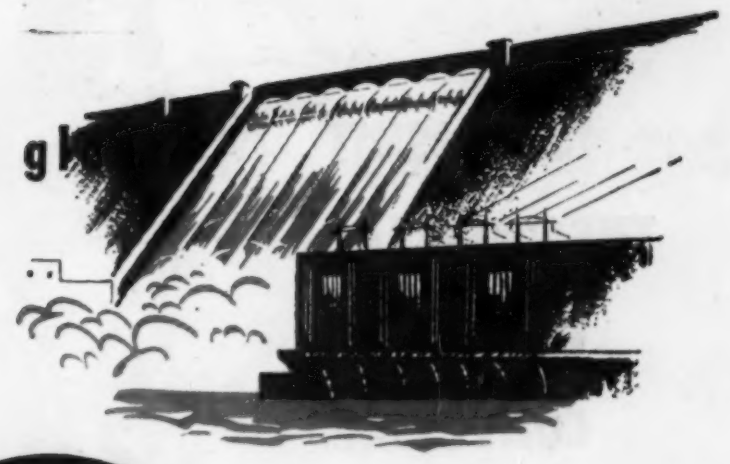
Change in Research

One result of the difficulty of securing plant for new processes has been a change in research activities. While theoretical and laboratory research is still being carried out on the largest possible scale commensurate with the available labor, translation of research findings to the pilot plant and commercial scale must necessarily wait. Managements are faced with the dilemma of either diverting new plant needed to enlarge established productions to new products or postponing the development of new products and processes in the interest of meeting the needs of their customers for traditional manufactures. The choice is not easy and producers are investigating market conditions for potential products carefully. Moreover, they try to determine likely trends in various consuming industries long in advance in order to decide which lines of research should receive priority.

This difficulty of following up research advances on the semi-commercial level explains why so many new chemical developments have been announced and so few of them are being applied in practice. From official and private computations it appears that the demand for various essential chemicals in common use will not be fully met before 1951 even though additions have been and are being made to production facilities for them. In the circumstances the dice are heavily weighed against new products which have still to prove their commercial

an SK "reason why"

shows flow at a gl



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value and are not established profit-earners. Leading chemical manufacturers in Britain realize that neglect of research and development would be fatal, but not all of them find it easy to strike the happy medium between extension of existing production and preparation for new production. This problem is particularly difficult in those younger branches of the industry in which very little practical experience has as yet been gathered about production problems, marketing opportunities, and the relative value of different products to various potential consumers.

Quite a few small and medium-sized chemical companies have approached the organized capital market with new share issues. All these firms are in need of larger production facilities and find it impossible to finance these out of their own resources. With taxation at its present high level any new development of importance requires outside financing. Public funds, however, are easily attracted to the chemical industry as few chemical shares are quoted on the London Stock Exchange and interest in the industry is growing. New capital issues are therefore regularly over-subscribed.

The chemical export trade has developed satisfactorily so far this year, and it is hoped that the new export targets will be attained. These new objectives are substantially smaller than the targets fixed originally but demand an increase by one-tenth in exports of chemicals, dyes, paints and pharmaceuticals over the best months of last year. In the first half of 1948 they are to reach 165 percent by volume of the average exports of 1938, and in the second half they are to rise to 173 percent.

British Reveal Operation of Low Energy Pile at Harwell

THE graphite low energy pile at the British Government's atomic research unit at Harwell started operations last August.

The secrecy surrounding certain operations at the research center was lifted when the Ministry of Supply made public an address made to the Atomic Scientists Association by Dr. H. W. B. Skinner, deputy director at Harwell.

Skinner also revealed that a simple cooling mechanism had since been put into action and the power had been taken up to the rated figure of 100 kw. and beyond for short periods. This pile was built for experimental work in physics and on materials; its flux was small for the manufacture of tracers, but the pile will produce 5 to 10 curies of radio-

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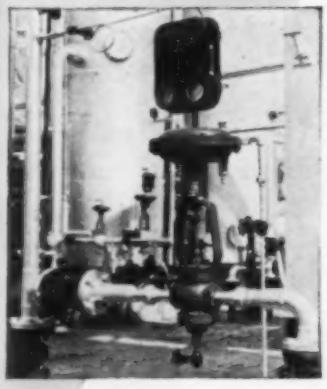

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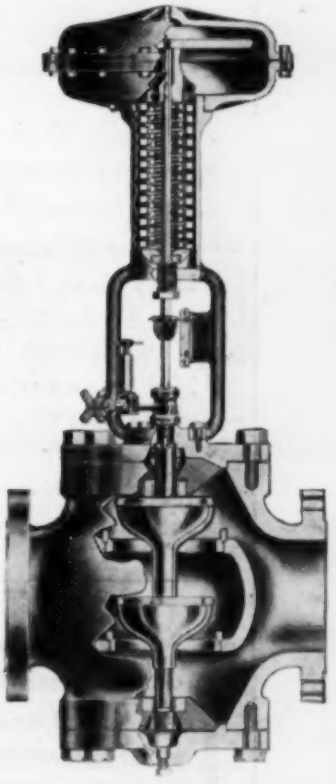
Climax engineers are ready to aid you in every way. A letter from you will put them to work for you. Write today.



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- May be used with hydrocarbon solvents
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phosphorus of low specific activity a month.

In the next Harwell pile which should be working during 1948, the power of operation will be in the region of several thousand kilowatts, because the cooling of the uranium will be accomplished by passing a high-speed stream of air in the channels around the rods.

The metal will be sheathed with aluminum to prevent oxidation and to contain the fission products. The emerging gas temperature would, however, be too low for efficient production of electric power, but it is hoped to use heat of the pile for warming buildings.

This pile will operate at a neutron-flux of something like 100 times that of the first, making possible production of nearly all the radioactive tracers required for the country. A few useful isotopes would be limited in quantity and a few others would only be manufacturable by the use of a cyclotron. The pile will provide a powerful source of fission products, distributed among the 35 elements from zinc to gadolinium, and a small quantity of plutonium for experimental work.

The pile would also be important in the study of the irradiation of various materials in an intense atmosphere of neutrons. These piles will probably be followed by others, more directly concerned with power production.

Another aspect of the work at Harwell covers development of measuring instruments for radioactive radiation; among them are a number of types of health instruments, one of these is a hand monitor for making sure that workers who had handled radioactive products had no residual activity left on their hands.

FRENCH AND ITALIAN CHEMICAL INDUSTRIES WILL BENEFIT FROM PROPOSED CUSTOMS UNION

Customs and economic union between France and Italy is expected to lead to a growth of cooperation and understandings between the chemical industries of the two countries, as their economies become more closely interlocked. First protocol for the customs union was signed in March, after six months of study by a joint Franco-Italian commission and

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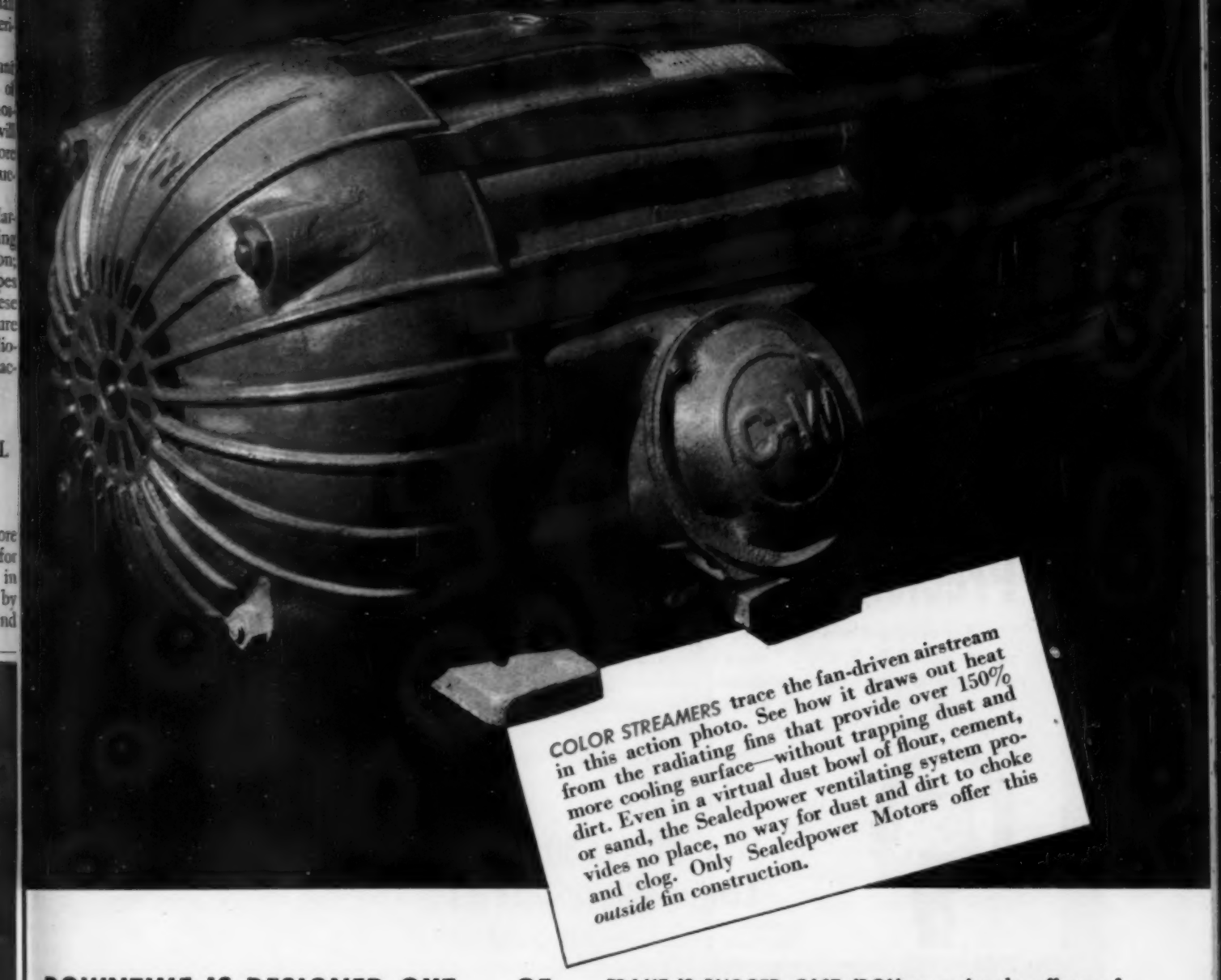
DEPENDABILITY

Dust rides this Cooling Slipstream

OUTSIDE and AWAY



COLOR STREAMERS trace the fan-driven airstream in this action photo. See how it draws out heat from the radiating fins that provide over 150% more cooling surface—without trapping dust and dirt. Even in a virtual dust bowl of flour, cement, or sand, the Sealedpower ventilating system provides no place, no way for dust and dirt to choke and clog. Only Sealedpower Motors offer this *outside* fin construction.

DOWNTIME IS DESIGNED OUT . . . OF C-W SEALEDPOWER MOTORS

THIS EXCLUSIVE DESIGN gives you years and years of cool, clean operation on the dirtiest jobs without time out to clean out dirt-and-dust-traps common to other totally enclosed motors. Even airborne lint that packs and clogs is no problem. It can be cleared from the air grille of the fan-cowl with a whisk of a brush, while the motor is running.

FRAME IS RUGGED CAST IRON to resist the effects of moisture and corrosive conditions like those in textile finishing and chemical plants. There is no steel to rust.

AVAILABLE IN NEW RATINGS . . . 3 to 40 hp at 1800 rpm. Write for Bulletin SL-300-2 giving full details of this unique Crocker-Wheeler Sealedpower Motor. Also, get complete descriptive data on the general C-W line of AC and DC motors and generators, and flexible couplings.

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Bourdon tubes in the ACRAGAGE are 20% to 30% longer than average . . . resulting in the following advantages: less strain per unit length on the spring; increased durability; longer fatigue life; heavier wall thickness for added safety; greater tip-travel — providing sustained accuracies to within one-half of one percent!

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meetings between industrialists of the two Latin lands.

A domestic market of nearly 100,000,000 people (including North Africa) will allow considerably more concentration and lowered costs of production in some of the chemical industries, according to the joint commission. This means better prospects for exports.

In the soda field, Italy is unlikely to enter the export field extensively, but the French hope to raise their exports of carbonate to 240,000 tons by 1952 and of caustic soda to 120,000 tons.

Coloring matter exports as a whole should remain fairly evenly divided between the two countries, but with specialization in individual products. Export goal for 1952 is set at 20,000 tons for the bi-country total.

France is likely to continue the dominant partner in exports of pharmaceuticals.

Fertilizer Outlook

In phosphate fertilizers, Italy should be able to meet her needs, while France will continue reduced exports to other countries. Both countries plan to increase nitrate fertilizer output sufficiently by 1952 to cover practically all their needs, in contrast to the large prewar imports. Italy will be able to furnish all France's citric acid needs and continue to export. In the field of gums and resins, the two countries may be able to supply each other more fully than in the past.

The same joint commission has brought together considerable information on 1947 output and structure of the chief branches of French and Italian chemical industry.

In nitrate fertilizers the French industry produced 178,000 metric tons last year, and the Italian industry about 100,000 tons. The French hope in the next few years to boost their output nearly 100 percent, but expect consumption to rise even faster. But the Italians, with plans for tripling their output, would be able to ship 75,000 tons a year to France. So on balance, if these large-scale plans materialize, the two countries will need to import very little after 1952.

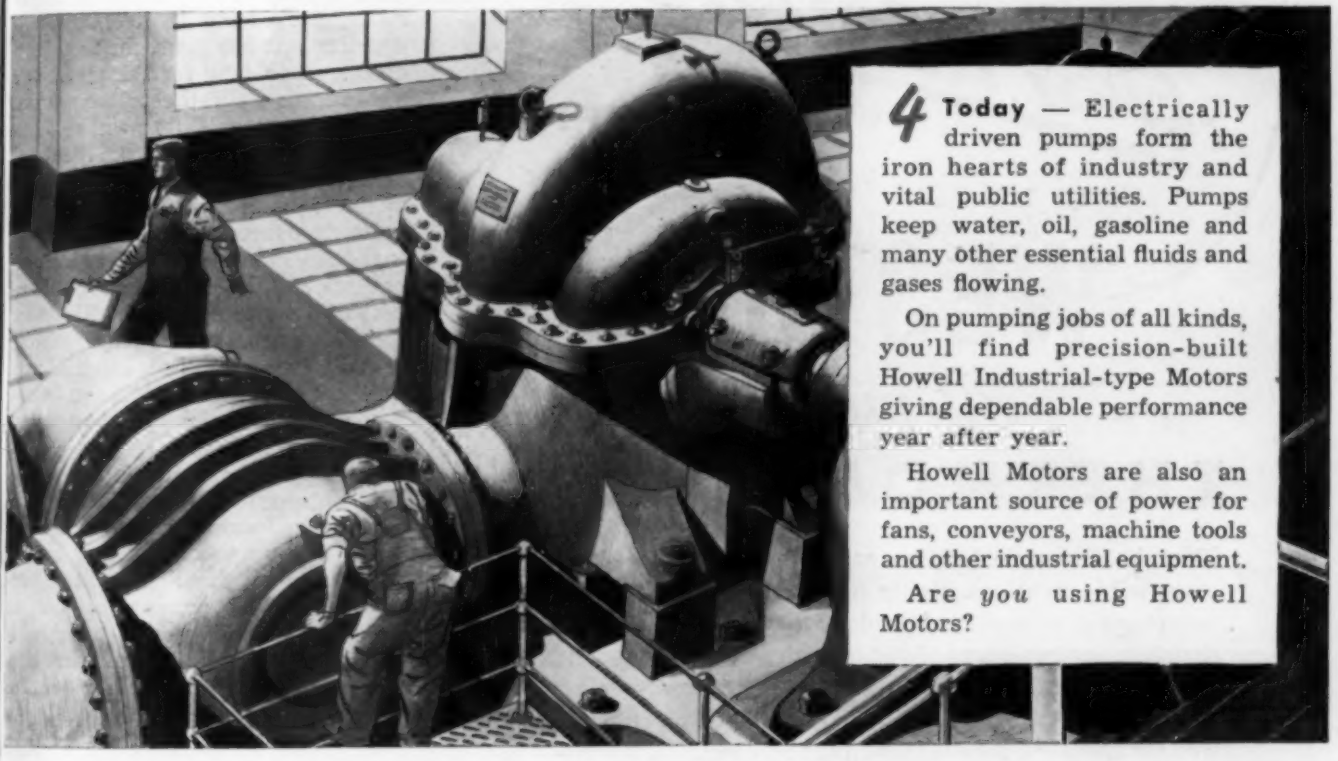
France's nitrate fertilizer industry is not concentrated, financially or otherwise, except for the 25 percent of the plants owned by the State. About 27 plants are active in the industry, most are in the North and Southwest. In Italy, on the contrary the great Societa Montecatini with several scattered plants, two Vetrocoke groups (plants at Porto Marghera near Venice) and the Societa Terni (at Terni)

1 1643—Torricelli, Italian physicist, hastened the development of modern hydraulic pumps when he found water could be raised in a tube by air pressure.

2 1840—Steam pump engines were helping to keep water out of mines. But low-cost electricity which put the *big* push behind pumping was still to come.

3 1915—Howell "Red Band" Electric Motors were introduced. Soon, these rugged, industrial-type motors gained wide recognition in this and other industries.

PUMPS . . . IRON HEARTS OF INDUSTRY!



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On pumping jobs of all kinds, you'll find precision-built Howell Industrial-type Motors giving dependable performance year after year.

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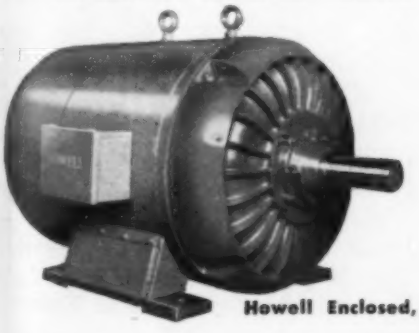

Howell Enclosed, Fan-Cooled Motors—Type K

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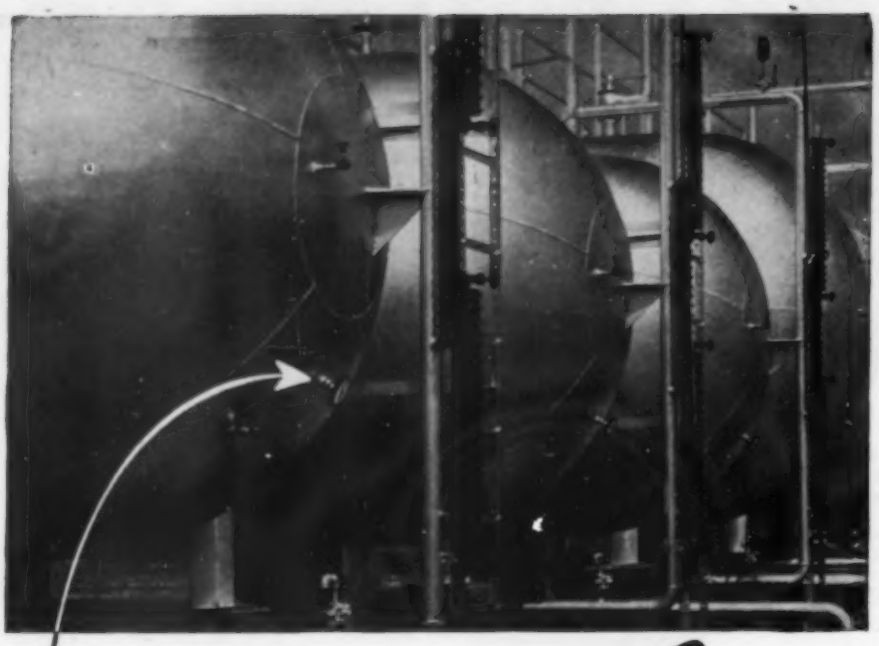

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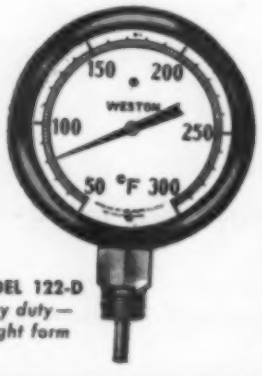

MODEL 122-D
heavy duty—
straight form

MODEL 222-D
heavy duty—
angle form

account for nearly 90 percent of the output.

Production of phosphate fertilizers in France during 1947 was 230,000 tons and in Italy about 200,000 tons. Both countries hope to increase output 30 or 40 percent during the next few years. Financially the industry is quite concentrated in both countries. In France, 40 percent of the capital is represented by the Societe Saint-Gobain, and 25 percent by the Etablissements Kuhlmann; in Italy 70 percent is under Montecatini. Actual plants however are both numerous and scattered. The 65 French plants range from 1,000 to 60,000 tons in capacity; while Italy has 74 plants.

Sulphuric Output Grows

Sulphuric acid output was something over 1,000,000 tons in France last year, and about 650,000 tons in Italy. Each country however hopes to increase output by 800,000 tons over the next few years, for their own needs. Here (and for the phosphate fertilizers as well) the problem arises of whether Italian pyrites will be available to meet some of the increased demand, since the quality of these pyrites is falling off.

Italy produced more dyes and colorants than France in 1947. Her output reached 20,000 tons (9,000 exported) compared to 14,000 tons (3.600 exported) for France. More of Italy's semi-finished exports may flow to France under the customs union, reducing the French demand from other sources.

Both French and Italian dye industries are highly concentrated. Francolor, a trust created by the Germans under the occupation and now owned 51 percent by the French State, accounts for 75 percent of output through its Paris region factories. Fifteen percent is produced by the SIBA group (plant at Saint-Fons) and the rest by Mulhouse. In Italy, Montecatini accounts for about 60 percent of the total production.

Plastics output is still low but expanding rapidly in both countries. France produced 12,600 tons in 1947 and Italy 23,000 tons. Principle types produced were as follows:

	France Tons	Italy Tons
Cellulose acetate	1,400	1,000
Vinyl	4,200	900
Phenol	6,000	10,000
Amino	1,080	4,000
Celluloid		1,500
Other		2,600

The French hope to quadruple their output in the next few years, and the Italians plan to raise theirs by 50 percent. A considerable degree of concentration exists in France in

"STAINLESS STEEL cuts our maintenance costs..."

—say processing plant superintendents

Stainless steel was selected by this sulfite pulp mill to forestall corrosion of blow-pit drainer bottoms. Liquor drained through perforations in the stainless steel plate is a water solution of sulfurous acid and calcium bisulfite. Secondary benefits are improved cleanliness of both equipment and solution.

● Expenses promptly begin to drop when you install equipment made of Republic ENDURO Stainless and Heat-Resisting Steel.

The reasons are simple. ENDURO is remarkably easy to clean and to keep clean . . . saves you money that way. It is strong and tough, resistant to roughest use . . . a profitable, long-term investment. Then, too, long-lasting ENDURO resists the action of most acids and alkalies . . . is free from the damaging effects of rust and corrosion . . . never needs painting, plating or refinishing. And, it retains its high physical qualities at elevated temperatures.

You'll save on maintenance—and you'll cut replacement costs, too—when you specify one of the wide range of ENDURO Stainless and Heat-Resisting Steels. Talk with your equipment manufacturer, or write us for more information.

REPUBLIC STEEL CORPORATION

Alloy Steel Division • Massillon, Ohio

GENERAL OFFICES • CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, New York

REPUBLIC STEEL

Enduro Reg. U. S. Pat. Off.

STAINLESS STEEL

RESISTANT TO RUST AND CORROSION • RESISTANT TO HEAT • HIGH IN STRENGTH • EASY TO FABRICATE
EASY TO CLEAN • FREE FROM CONTAMINATION • EYE APPEALING • LONG LASTING • LOW ULTIMATE COST

A PRODUCT OF REPUBLIC STEEL

SUBMIT YOUR GRINDING PROBLEMS TO

WILLIAMS

"The Leader in the Industry"

STANDARD MACHINES FOR ANY REDUCTION JOB

- CRUSHERS
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WILLIAMS is the world's largest organization of crushing, grinding and shredding specialists and have developed standard machines for the reduction of practically every material whether animal, mineral or vegetable. No matter what your particular job consists of—grinding chemicals to 400 mesh, crushing 4 feet cubes of rock or shredding steel turnings, you can profit by Williams' experience.

Our modern, up-to-date Testing Laboratory is at your service—why not send us a sample of your material and let us make a test run—all in strictest confidence. The Williams Engineering Staff offers its assistance to all industries.

THE WILLIAMS PATENT CRUSHER & PULVERIZER CO.
2706 North Ninth St. St. Louis 6, Mo.

Sales Agencies Include

CHICAGO 5 — 37 W. Van Buren St.
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the hands of Saint-Gobain, Rhone-Poulenc and Francolor. In Italy Montecatini has a quarter of the output. Apart from these major firms however a vast number of small establishments have entered the plastics field.

Soda products output in France was 580,000 tons for carbonates and 225,000 tons for caustic soda. Of these quantities about 180,000 tons of carbonate were exported and about 60,000 tons of caustic soda. In Italy carbonate output was 132,000 tons and caustic production was 170,000 tons, with none exported. All of the Italian output and three-quarters of the French is under the Solvay holding company.

So far as French chemical exports are concerned in the near future, last January's devaluation of the franc does not seem likely to have much stimulating effect. Latest government price figures show semi-finished chemicals up about 50 percent and finished chemicals doubled in price since the beginning of the year.

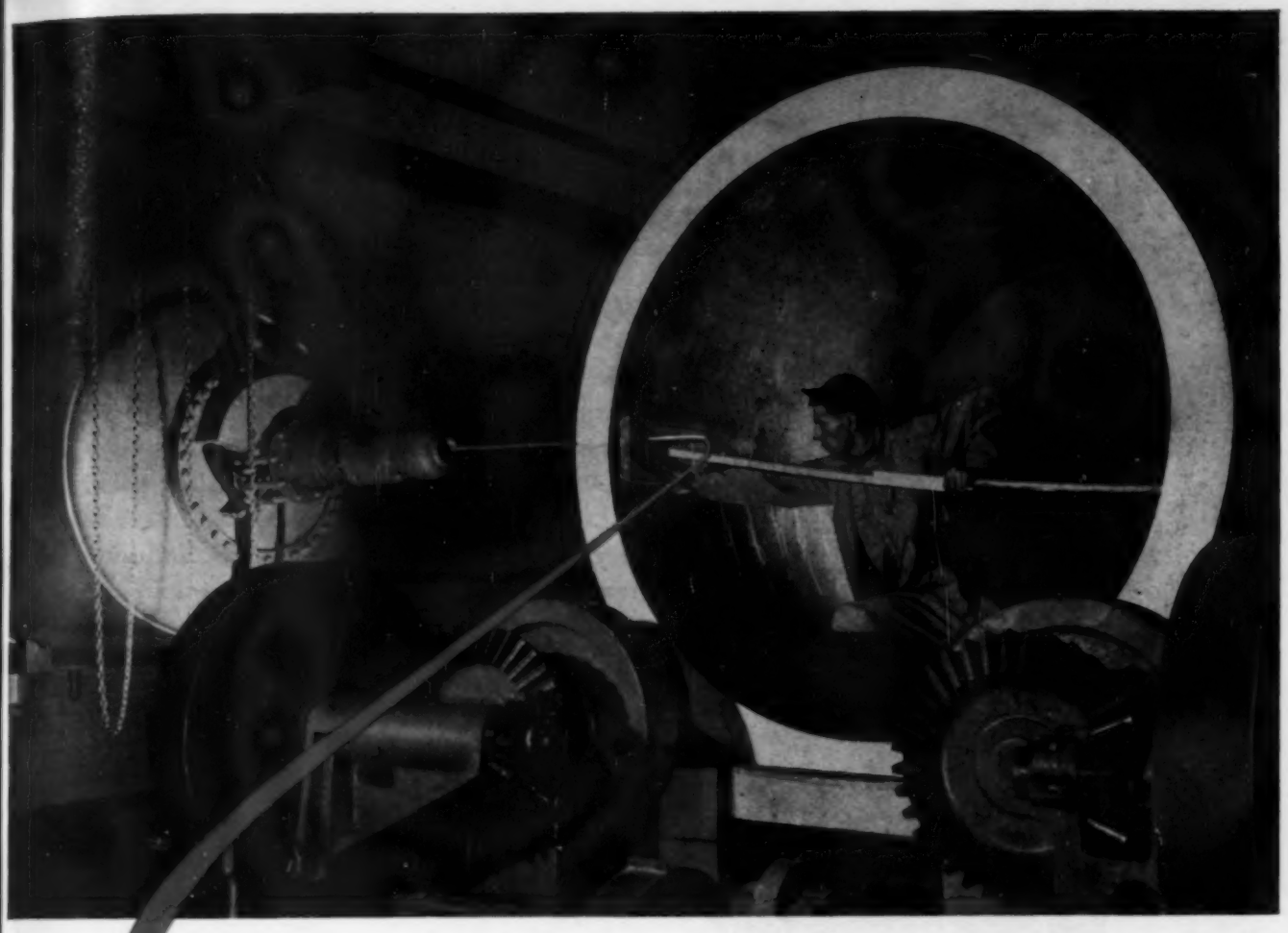
Australia Faces Shortage of Calcium Carbide

EXTENSION of carbide-based synthetics by Australia's chemical industries and undiminished popularity of oxy-acetylene welding in metal fabrication has upset supply-and-demand relations in the Commonwealth calcium carbide market. Against an annual production of 5,000 tons, demand has soared to 17,000 tons a year. Most of this is absorbed by the five acetylene plants of Commonwealth Industrial Gases Ltd.

But increasing amounts are finding use as starting material in the synthetic chemical industries. Imperial Chemical's Australian branch plants use CaC_2 in the production of trichlorethylene and perchlorethylene. It will soon be required in the manufacture of polyvinyl chloride, tetrachlorethane, pentachlorethane and hexachlorethane, now planned by ICI.

Timbrol Limited, the fabulous upstart in Australia's plastics industry, will be in the market soon for calcium carbide. It will be used in the synthesis of melamine resins, and undisclosed production plans call for still more CaC_2. Timbrol discontinued, however, production of calcium cyanamide and dicyanodiamide, both derived from carbide.

Considerable quantities also are consumed in production of acetylene black for use in dry-cell batteries. Electronics Limited, of Melbourne, is producing acetylene black under a license arrangement with Shawinigan Chemicals Limited.



ANOTHER B&W "FIRST" FOR BETTER PRESSURE VESSELS

The 2,000,000-volt x-ray machine shown at left in the photograph above is the newest and largest of twelve similar machines used by B&W to make certain that welded seams in heavy steel pressure vessels meet industry code specifications. Largest ever constructed for inspecting welds, this newest unit is eight times as powerful as the average hospital x-ray.

This pioneering step typifies the advanced methods that extend to all phases of process equipment construction at B&W . . . of B&W's unending search for better tools and better methods to supply the process industries with safest, and soundest pressure vessels of carbon, alloy, and Croloy-Clad plate.

5-75

PROCESS EQUIPMENT — Alloy, Clad, and Bonded Pressure Vessels . . . Heat and Abrasive-resistant Alloy Castings . . . Special Process Equipment.

★ ★ ★

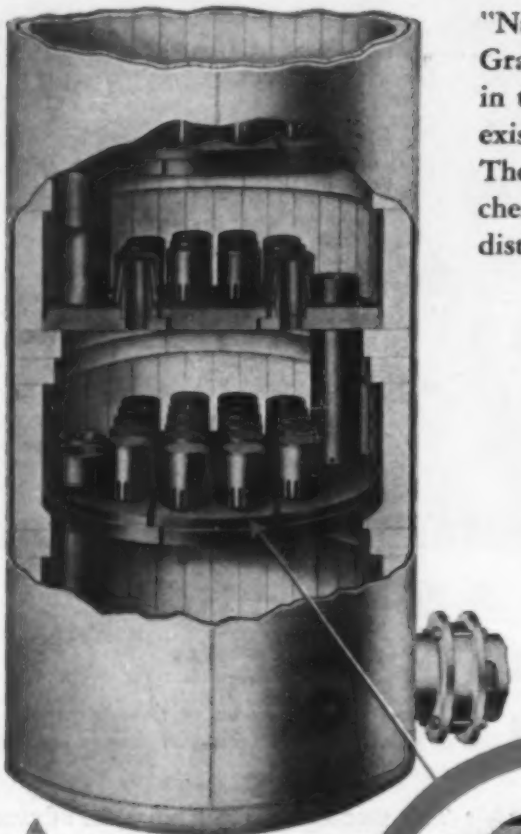
OTHER B&W PRODUCTS — Stationary and Marine Boilers . . . Boiler Components . . . Chemical Recovery Units . . . Pulverizers . . . Fuel Burning Equipment . . . Refractories . . . Seamless & Welded Tubes.

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: ALLIANCE AND BARBERTON, O.; AUGUSTA, GA.

THEY'RE ACID-PROOF AND ALKALI-PROOF!

"NATIONAL" GRAPHITE BUBBLE CAPS AND TRAYS



"National" Graphite and "Karbate" Impervious Graphite bubble caps and trays last equally well in towers where either acid or alkaline conditions exist or where these conditions exist alternately. They are widely used in the organic and inorganic chemical fields, in scrubbing, absorption, and distillation towers.

OTHER ADVANTAGES ARE:

1 Easier to install because of the one-piece bubble cap construction.

2 Light weight with adequate strength.

3 Highly resistant to thermal shock.

4 No metallic contamination or plugging of slots by the products of corrosion.

A typical installation of "National" bubble caps and trays in a brick-lined tower. Monolithic or fabricated trays are easily adapted to all types of tower construction, including standard "Karbate" towers.

Cutaway section of a "National" bubble cap, illustrating the exceptionally strong one-piece construction.

The terms "National" and "Karbate" are registered trade-marks of

NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

These products sold in Canada by Canadian National Carbon Company Limited

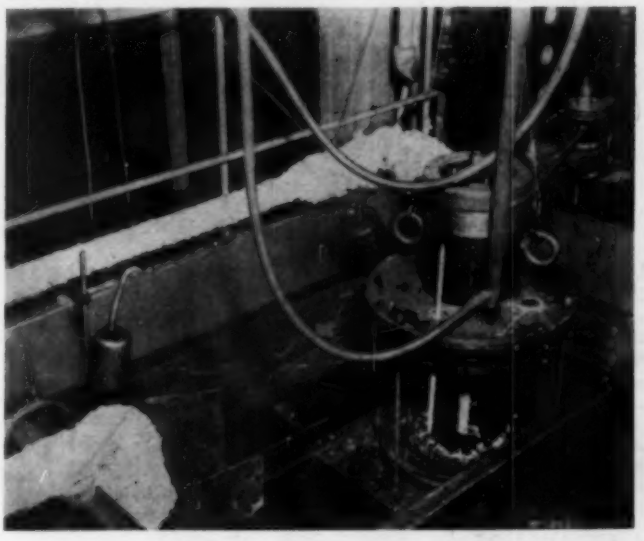
FOR MORE INFORMATION ON "NATIONAL" GRAPHITE AND "KARBATE" IMPERVIOUS GRAPHITE BUBBLE CAPS AND TRAYS, WRITE TO NATIONAL CARBON COMPANY, INC., DEPT. CE.

THE CORROSION FORUM

Edmond C. Fetter, ASSISTANT EDITOR

Sulphuric Acid versus Construction Materials

Part I of a symposium in which typical materials of construction are evaluated for services involving sulphuric acid.



A useful corrosion tester is this device developed to test Worthite. Specimens are fastened to edge of disk, immersed in acid in glass container, and rotated at speed corresponding to service velocity of acid over metal. Acid is heated by oil bath, here removed to show inside of acid container.

RUBBER LININGS

O. S. TRUE
U. S. Rubber Co.
New York, N. Y.

RUBBER linings have been extensively used for handling limited concentrations of sulphuric acid in the chemical process industries. It is possible to satisfactorily handle 50 percent concentrations at room temperature with soft or semi-hard rubber. Concentrations up to 70 percent may be handled at 120 deg. F. with neoprene or special ebonite compounds. Laboratory tests indicate that concentrations up to 70 percent at 158 deg. F. can be satisfactorily handled with butyl rubber. Concentrations up to 25 percent may be handled at temperatures up to 200 deg. F. with special ebonite compounds.

Based on the above, rubber-lined tanks have been extensively used in metal pickling operations, the rubber lining usually being protected with inner linings of acidproof brick or cement, usually being provided to protect the rubber against mechanical abuse. Rubber linings have been used in evaporators and crystallizers for the recovery of salts from sulphuric acid solutions as well as for the distribution piping and storage tanks used in connection with such operations. Rubber-lined tanks have been used for sulphuric acid mixing tanks and are entirely satisfactory for this service if sufficient agitation is provided to prevent concentrated sulphuric acid from settling to the bottom of the vessel and from coming into contact with the surface of the rubber.

Rubber-lined storage and process equipment is used in many industries such as in the pigment industry for handling acid solutions of ferro-sulphate. Rubber-lined centrifugals are used for separation of solvents from mother-liquor. Rubber-covered fans, hoods, and ducks are used for the disposal of sulphuric acid fumes. There are many applications of sulphuric acid solutions in industrial processing, and rubber lining is suitable for use in connection with most of these applications, provided the concentrations and the temperatures as specified above are not exceeded.

CAST IRON AND STEEL

ALBERT W. SPITZ
American Cyanamid Co.
New York, N. Y.

CAST iron and carbon steel are extensively used in sulphuric acid service for concentrations from about 80 percent up to and including 100 percent. With concentrations over 98 percent and temperatures up to 140 deg. F., steel is recommended for tanks and piping. For valves and pumps where the velocities are high, chrome-nickel alloys are more satisfactory. In the range between 100 percent and 102 percent, neither cast iron or steel are serviceable. Above 102 percent steel is satisfactory with the same exceptions as between 98 percent and 100 percent. Where the concentration is between 90 and 98 percent steel is recommended for tanks and cast iron for pumps and valves at temperatures up to the boiling point. Both may be used for piping, although cast iron is preferred at the higher temperatures.

In the concentrations between 80 percent and 90 percent at atmospheric temperatures, cast iron and steel are both reasonably serviceable for the various uses, although the corrosion is greater in this range than it is for the higher concentrations. For values much below 80 percent, the use of iron and steel is not recommended as the corrosion rate is excessive.

WORTHITE

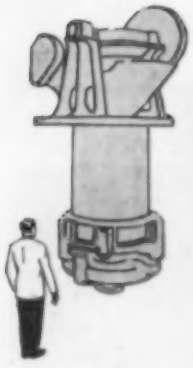
E. T. COLLINSWORTH
Worthington Pump and Mach. Corp.
Harrison, N. J.

WITHIN stipulated conditions of temperature and concentration, there are many chrome-nickel alloys which can be used for sulphuric acid. Selection on an economic basis will have to consider first cost, availability, versatility of use and standardization of equipment. Worthite (20 percent Cr, 25 Ni, 3 Mo, 3.5 Si, 1.75 Cu, 0.6 Mn, 0.07 max. C.) has proved eco-

JACKSON & CHURCH COMPANY'S

NEW and IMPROVED

ZENITH PULP PRESS WITH THE HYDRAULICALLY ACTIVATED FLOATING CONE



JACKSON & CHURCH COMPANY'S ZENITH PRESS offers **GREATER** efficiency . . . **GREATER** profits . . . with the hydraulically-operated cake discharge port or "floating cone."

Long the finest dewaterer on the market, Zenith's new **100%** automatic continuous operation assures **CONSTANT, UNIFORM** discharge pressures at any predetermined degree by finger-tip control. **Cake Uniformity assured.**

With new Zenith you'll notice **decreased maintenance costs and minimum power consumption** as compared to fixed-opening equipment.

These **J & C** engineering triumphs . . . **found only in Zenith Press** . . . are available to paper pulp manufacturers, canneries, corn starch plants, fish reduction plants, meat packers, glue plants, and citrus and waste drying plants.

For engineering or additional data write Jackson & Church Company at Saginaw, Michigan.

A PRODUCT OF

JACKSON & CHURCH COMPANY, SAGINAW, MICHIGAN

WORK WELL DONE SINCE '81

Fabricated Units by Multi-Metal

This grease strainer, shown with a set of inner cartridges, is an outstanding example of Multi-Metal's ability in the design and fabrication of wire and filter cloth units. Units like these have provided industry with the answers to more efficient, less expensive processing operations. Specially fabricated units can be promptly and economically custom-built to your requirements.

Multi-Metal also supplies a wide range of filter and wire cloth, of all meshes, weaves and metals — by the yard, piece or roll. For a complete description of our filter and wire cloth stocks and fabricating resources, write for the 32-page Multi-Metal catalog. Send prints and specifications for prompt recommendations.

SEE US AT THE EXPOSITION

We'll be looking for you at the International Petroleum Exposition, May 15-22, Tulsa, Oklahoma. Booths 30 and 31 in the KANSAS Building.

Serving the Processing Industries More than 35 years

Multi-Metal

WIRE CLOTH COMPANY, INC.

1350 Garrison Ave., New York 59, N. Y.

nomical for pumps, valves, companion flanges, hose nipples, bar stock, screw machine products, and welding electrodes.

Service limitations, as found by laboratory test and much plant experience, are as follows: At ambient temperatures, all strengths of sulphuric acid may be handled satisfactorily. In the 45 percent range the limit is 175 deg. F.; for a 93 percent solution it is around 125 deg. F. max.; for 98-100 percent, 160 deg. F. max.

A few of the hundreds of installations of Worthite pumps and valves in sulphuric acid services are listed below. Product made, services involved, and solutions handled are listed in order.

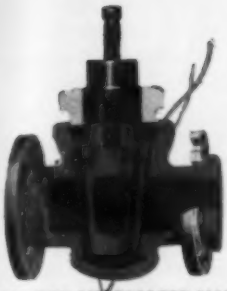
Batteries; circulating; pure sulphuric acid.
Byproduct coke; saturator; ammonium sulphate.
Electrolytic caustic soda; dryers, evaporators, filters; 66 deg. Be. sulphuric acid, caustic soda.
Cellulose acetate; mixer, acetylator, recovery; sulphuric acid, bleach, cellulose acetate, acetic acid, acetic anhydride.
Phosphoric acid (wet process); agitators, mixers, filtering, measuring, evaporation; 94 percent sulphuric acid, slurry phosphoric acid.
Petroleum refineries; treating sludge, separating, circulating, alcohol recovery; 30-66 deg. Be. sulphuric acid (to boiling point); acid sludges, caustic soda.

Following are the results of some plant tests on Worthite in sulphuric acid.

1. Diluting tank in chamber plant; 20 percent sulphuric acid; 104 deg. F.; specimen exposed 198 hr.; 0.03 mils per yr.; no pitting.
2. Acid recovery from sludge; 15-35 percent sulphuric acid plus sludge, tar and oil; 120-200 deg. F. (176 deg. F. av.); specimen exposed 450 hr.; unaerated; agitated violently with live steam; 17 mils per yr.; no pitting.
3. Acid recovery from sludge; 15-35 percent sulphuric acid by wt. in large vol. sludge, oil and tar; 120-200 deg. F. (176 deg. F. av.); specimen exposed 700 hr.; unaerated; agitated violently with live steam; 79 mils per yr.; max. pit 12 mils.
4. Acid recovery from sludge; 35 percent sulphuric acid and sludge to which was added 86 percent alkylation acid resulting in conc. of 58 percent sulphuric; 148-255 deg. F. (196 deg. F. av.); specimen exposed 380 hr.; unaerated; agitated violently with live steam; 236 mils per yr.; no pitting.
5. Leaching ilmenite ore; 21 percent "spent acid" (sulphuric) plus $FeSO_4$ and $TiSO_4$ (latter acts as corrosion accelerator); 194 deg. F.; specimen exposed 8 days; unaerated; slight agitation; 15.7–49.7 mils per yr.
6. Specimens exposed in dye range using algosal or indegosal dyes on piece goods; 66 deg. Be. sulphuric acid plus varying amounts of nitrous acid formed by continuous addition of $NaNO_2$; 105–175 deg. F.; exposed 171 days; slight aeration and agitation; less than 0.1 mils per yr.
7. Sulfonation of pyridene; 65 percent oleum plus 1 part pyridene; 329–34 deg. F.; specimen exposed 45 hr.; unaerated; moderate agitation with stirrer; 38 mils per yr.; no pitting.

A mechanically-agitated device has been developed to test the value of Worthite for handling sulphuric acid under commercial conditions. It may be useful to readers for their own testing and is shown in an accompanying photograph. The acid in a glass container is held at a predetermined temperature by an automatically controlled

. . . THESE VALVES are made for corrosive services like these . . .

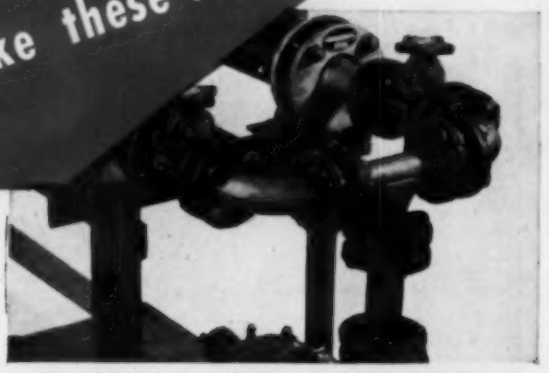


DURCO TOP LUBRICATED VALVE
Bull. 617

The plug will turn freely under difficult conditions, provided lubricant is maintained.

Tough, corrosion-resistant Teflon diaphragm provides a seal between top of plug and body to double the previous pressure limit, without leaking at the gland. This diaphragm has taken 10,000 turns without being cut or visibly worn.

Sizes 1", 1½", 2", 2½", 3", 4", 6".

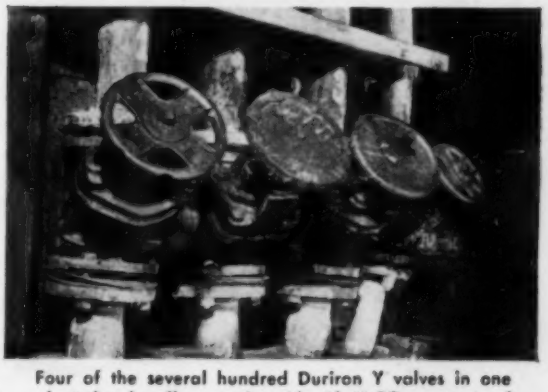


Two of four Duriron diaphragm valves in a packaged Durco Heat Exchanger Unit for bright nickel plating service.

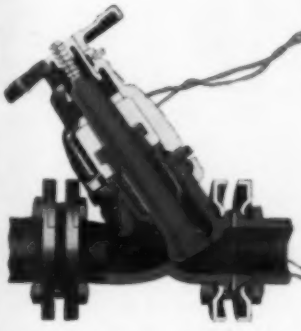
DURCO HILLS-McCANNA
(Saunders Pat.) DIAPHRAGM VALVE

No stuffing box. Tough, resilient, reinforced molded diaphragm isolates the operating parts from corrosive solutions. Closure can be effected even over solid particles. Diaphragm is inexpensive and easy to replace. Body can remain in line.

Sizes 1", 1½", 2", 3" and 4".



Four of the several hundred Duriron Y valves in one plant that handle organic acid with H_2SO_4 contents of 1½% to 30%.

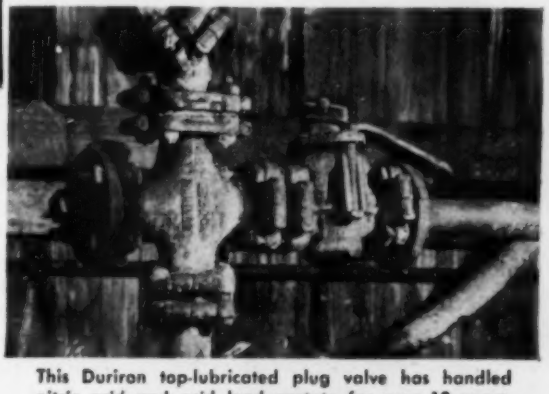


DURCO SERIES 35 Y VALVES
Bull. 615

Recommended where lubricant is undesirable and for close regulation of flow. Unusually straight flow as compared to most Y valve designs. Readily adapted to air operated motors. Can be converted to angle valve by changing body.

Sizes 1", 1½", 2", 3", 4" and 6".

PROMPT DELIVERY — As this advertisement goes to press, reasonable quantities of these three types of valves can be shipped within a week to ten days. Otherwise three weeks is normal for Duriron valves; four weeks for Durichlor as large stocks of castings supplement the stock of finished valves. Prompt delivery may possibly be delayed by large orders, but improved facilities have tremendously increased production to insure good deliveries.



This Duriron top-lubricated plug valve has handled nitric acid and acid lead acetate for over 18 years.

These Durco Valves give you

MAXIMUM CORROSION RESISTANCE. Made of Durco's high silicon irons, Duriron and Durichlor, they have permanent resistance to every common corrosive. Unexcelled for sulfuric acid. Excellent for nitric, hydrochloric, acetic and hundreds of other corrosive solutions.

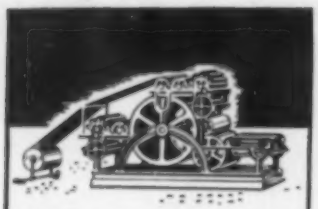
WIDE RANGE OF APPLICATION. These valves are the most popular types for corrosive service. Almost any problem of corrosive flow control can be solved with one of these designs. Check, angle, plunger-release, three-way, float and relief valves are also available.

Write, wire or phone for the bulletins listed, or ask for a Durco sales engineer to call.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

THE DURIRON CO., INC., DAYTON 1, OHIO
Branch Offices in Principal Cities

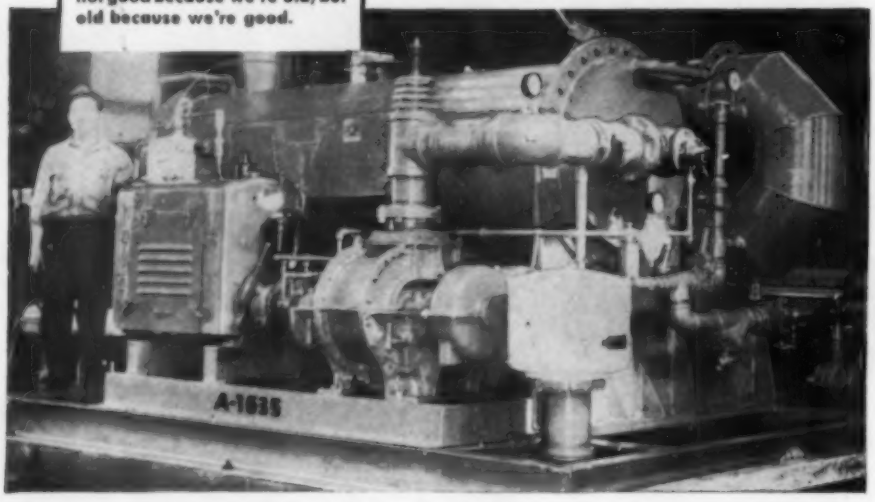
61-GM

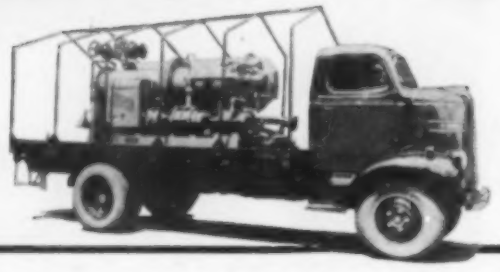


In 1865, William Bullock built the first press which printed from a continuous paper web or roll. Eleven years earlier, the first Roots Blower was built. We're not good because we're old, but old because we're good.

SMOTHER EXPLOSION HAZARDS

with R-C Inert Gas Generators





(Above) R-C Inert Gas Generator in oil refinery. Oil-fired, engine-driven. Capacity 45,000 CFH.

(Left) Portable unit, on truck, for fast service by public utility. Capacity 15,000 CFH.

Wherever inflammable gases or liquids are processed, handled or stored, there exists danger of fire or explosion. Such hazards are minimized in many plants with R-C Inert Gas Generators, which produce cheaply a mixture of nitrogen and carbon dioxide, in either stationary or portable units, with oil or gas for fuel.

R-C Inert Gas Generators have these outstanding advantages:

- Larger capacity in terms of weight and cost
- Low operating and maintenance cost
- Quick adjustments for complete combustion
- No adjustments, for same fuel, needed after shut-down
- Operation not affected by variations in back pressure
- Extremely quiet operation

Many years of satisfactory performance have proved the desirable qualities of R-C Inert Gas Generators. They are available in capacities from 1,000 CFH, up. For explosion or fire protection, or for inert gas production for processing operations, you'll obtain complete dependability from R-C equipment. For details, send for Bulletin 100-B14.

ROOTS-CONNERSVILLE BLOWER CORPORATION
805 Illinois Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE ROTARY CENTRIFUGAL
BLOWER BUILDERS R-C SINCE 1854
BLOWERS · EXHAUSTERS · BOOSTERS · LIQUID AND VACUUM PUMPS · METERS · INERT GAS GENERATORS

• • ONE OF THE DRESSER INDUSTRIES • •

oil bath. Specimens are suspended from the periphery of a horizontal disk of an inert, non-metallic material. This, by means of a variable speed motor, can be rotated at peripheral speeds from 0.8 to 45 fps. Glass baffles attached to the glass cylinder wall prevent rotation and vortexing of the acid; reflux condensers maintain concentration.

Advantages of the method: (1) A definite velocity of the acid is maintained over the surface of the specimen. (2) Uniform aeration is maintained throughout the liquid and in contact with all the surfaces of the specimen. (3) Gas bubbles will not adhere to the specimen to create areas of different potential. (4) Acid concentration is not lowered by introduction of moisture with air. (5) Commercial plant conditions are closely simulated.

Uniformity of the corrosion rates obtained with this mechanically agitated test eqnipment has been unusually good.

Galvanic corrosion between Worthite and lead deserves special notice. In most systems where lead and Worthite are in electrical contact with each other the Worthite, or any other stainless steel, is cathodic to lead and therefore protected; lead is rarely affected by anodic contact. Occasionally, however, lead takes on a thick, non-porous sulphate coating that is much more noble than the lead itself. Upshot: Worthite becomes anodic to the coating and is rapidly corroded. This can happen to any kind of stainless steel pump or valve in a lead-lined system, provided, that is, the sulphate coating forms on the lead. It doesn't happen very often but may be the answer to occasional unexpected failures. The condition can be cured by insulating the stainless from the lead or by addition of an oxidizing agent, such as one of the chromates.

HASTELLOY

C. G. CHISHOLM
Haynes Stellite Co.
Kokomo, Ind.

RELATIVELY few industrial corrosion problems involving the handling of sulphuric acid are caused by the chemically pure acid; most of the problems consist of handling H_2SO_4 plus some other organic or inorganic materials. For this reason, all tests on materials designed to resist sulphuric acid corrosion should be made under actual plant operating conditions before a final selection is made. Obviously it is impracticable to list, in a symposium of this nature, all the possible conditions of service and degrees of corrosion that might be present in

LOW COST DEMINERALIZED TAP WATER FOR THE LAB!

Replaces Expensive (Bottled) Distilled Water

The Permutit Laboratory Demineralizing Unit (Model LD-6) gives mineral-free water—*from a tap!* The LD-6 is designed for those who require small quantities (10-12 gals. per hour) of demineralized water for the usual laboratory work, and for those who wish to experiment with new processes involving ion exchange. Permutit demineralized water costs as little as 5% of the price of distilled water. Gone are the inconveniences of handling distilled water bottles!

The unit is portable and may be attached to practically any faucet or raw water line. The unit is sturdy, compact and non-corrodible throughout. With the continuously-reading, electrolytic conductivity indicator, the need for regeneration can be determined at a glance. Regeneration is quick and easy.

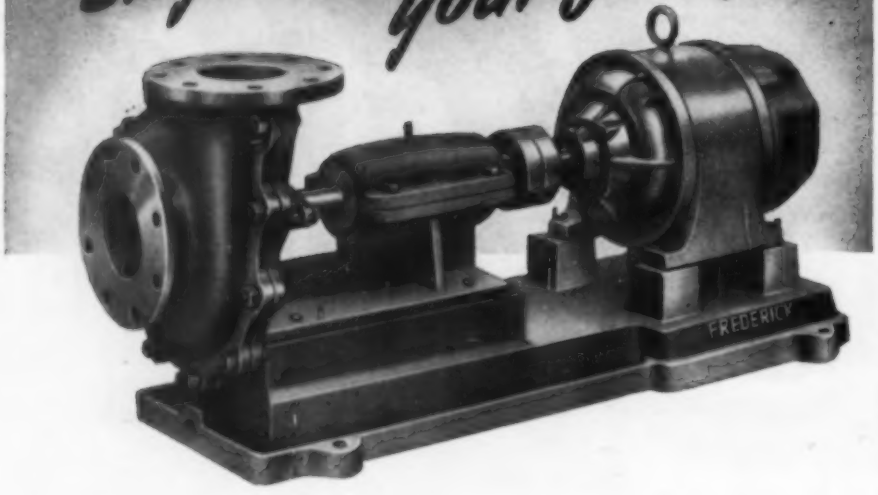
For full particulars write The Permutit Company, Dept. CE-5, 330 West 42nd St., New York 18, N. Y., or the Permutit Company of Canada, Ltd., Montreal.

Permutit

Water Conditioning — Ion Exchangers, Materials & Equipment

FREDERICK CENTRIFUGAL PUMPS

Engineered to fit your job!



Designed to assure continuous processing of any liquids, corrosive or non-corrosive . . . Powered by motors in the most popular horsepower range . . . Motors splash-proof and totally enclosed . . . Materials and workmanship of the finest . . . In constant use today in many of the Chemical Process Industries.

Send for this attractive, colorful booklet which gives details of construction and operation of Frederick Pumps. This booklet will show you how Frederick Centrifugal Pumps are engineered to fit your job. Ask for Bulletin 104.

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any one specific problem. However, the following general data on the four grades of Hastelloy alloy—A, B, C, and D—are given here to serve as a basis for comparing these alloys with other corrosion resistant materials designed for the same service.

Alloy A is satisfactory for handling 50 percent concentrations up to the boiling point; for concentrations above 50 percent, alloy A is recommended up to a maximum temperature of 160 deg. F.

Alloy B will handle 60 percent concentrations up to the boiling point; for concentrations above 60 percent, alloy B is recommended up to a maximum temperature of approximately 300 deg. F. Neither alloy A or B, however, is recommended for mixed acids or for use when sulphuric acid is mixed with strong oxidizing agents, such as cupric sulphate or ferric sulphate.

Alloy C will handle 50 percent concentrations up to the boiling point; for concentrations above 50 percent, alloy C is recommended up to a maximum temperature of approximately 160 deg. F. This alloy will also handle mixed acids, such as nitric and sulphuric, as well as sulphuric acid containing oxidizing salts.

Alloy D was developed for handling sulphuric acid at all temperatures and concentrations. However, we would like to inject a word of caution here in connection with using this alloy in equipment designed to handle a 55 percent concentration at boiling temperatures. In one application, alloy D heating tubes were used in a reboiler unit concentrating spent acid solution through a range of 50 to 60 percent strength. While this unit was in operation, it was noticed that an accelerated rate of attack was made on the alloy when the acid concentration was at 55 percent and the temperature was at the boiling point. For short periods of time, the rate of attack was as much as several inches per year penetration. The same results have been duplicated in laboratory tests where alloy D has been subjected to 55 percent solutions at the boiling point for long periods of time. No appreciable attack will be evident for weeks, then suddenly a rapid rate of attack will develop. The cause of this phenomenon is not known as yet.

All four grades of Hastelloy alloy are widely used for handling sulphuric acid in the chemical, petroleum, rayon, and steel industries. Alloys A, B, and C are used in the form of heating coils, blowpipes, steam legs, agitating equipment, pumps, valves, and piping; and alloy D is used in the form of valves, piping, pumps, and bayonet tube heaters.

In the chemical industry, heating tubes of alloy D have been used suc-

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cessfully in the Mantius-type sulphuric acid concentrator, as well as other types of concentrators for recovering spent acid. In the manufacture of dyestuffs, the Hastelloy alloys have been used in conjunction with glass-lined equipment for various sulphuric acid problems—especially during the processing of hydrocarbons in the manufacture of dye intermediates. Many applications for alloy C are found in the viscose rayon industry. Alloy C is especially valuable to this industry because of its excellent resistance to the corrosive action of the sulphuric acid-base coagulating bath.

The petroleum industry uses the Hastelloy alloys in equipment made for the processing of inorganic chemicals, and for the production of isopropanol and ethanol. Hastelloy D pump rods are also used by the petroleum industry to handle hot sludge acid. In the steel industry, alloys C and D are used to handle the normal 10 percent sulphuric acid pickling solution at a temperature of approximately 180 deg. F.

STAINLESS STEEL

W. G. RENSHAW
Allegheny-Ludlum Steel Corp.
Pittsburgh, Pa.

STAINLESS steels offer useful resistance to attack by many solutions of sulphuric acid where operating conditions of processes are properly controlled. In industrial processes, sulphuric acid is rarely used alone, usually being mixed with some other substances which very often have some effect on the corrosion rates. Certain salts or acids are especially effective in decreasing these rates, and a broad range of stainless applications are possible when these are present.

In solutions of pure sulphuric acid the useful range of stainless steels is limited. Type 316 (0.10 max. C, 16-18 Cr, 10-14 Ni, 2-3 Mo) and Type 317 (0.10 max. C, 18-20 Cr, 10-14 Ni, 3-4 Mo) possess the greatest corrosion resistance of the stainless steels to sulphuric acid. Type 316 can be used in up to 5 percent pure sulphuric acid solutions at room temperature while Type 317 is useful up to the same concentration at 150 deg. F. Pure concentrated sulphuric acid (66 deg. Be.) at room temperature is safely handled by any of the chromium-nickel stainless steels. The intermediate concentration ranges of pure acid solutions are severely corrosive to the stainless steels, but solutions of these same concentrations with other materials also present often can be safely handled by the stainless steels. None of these alloys are suitable for fuming sulphuric acid.

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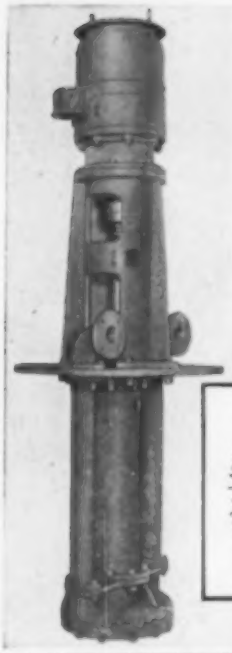

A newly-devised heating system circulates an abrasive-corrosive salt mixture at 850° F and even higher. To meet these tough requirements Lawrence engineers designed a vertical centrifugal pump with bearings and packing box outside the storage tank. An extra heavy shaft, in conjunction with dual opposed discharge outlets, minimize vibration and wear. All submerged parts are made of special alloys highly resistant to corrosion and abrasion of the hot mixture.

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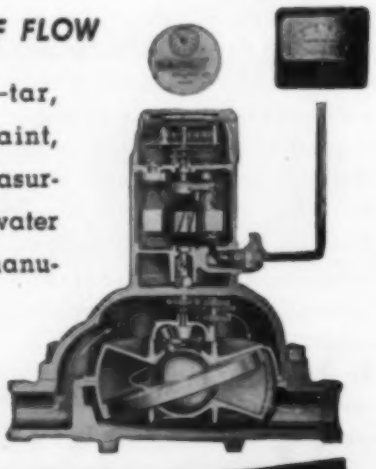

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COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

numerous processes involving mixtures of sulphuric acid and some other material which can effectively reduce attack on stainless steels to a negligible amount. To illustrate this marked effect, laboratory data have shown that the following percentages of salts or acids when added to a 30 percent solution of sulphuric acid at 200 deg. F. can reduce the corrosion rates on Types 304 and 316 to a negligible amount:

	Type 304	Type 316
Copper sulphate	1%	¼%
Chromic acid	2	½
Sodium dichromate	2	1
Sodium nitrate	20	10

In a pure sulphuric acid solution of 30 percent concentration at 200 deg. F. with no such materials added, corrosion rates as high as 3.5 and 2.4 inches penetration per month for Type 304 and Type 316, respectively, are not unusual.

Most of the sulphates have some inhibiting effect upon sulphuric acid attack. On many occasions sulphates are formed during reactions, and where these are formed in sufficient quantities sulphuric acid attack is prevented or retarded to such a degree that stainless steels can be used. Laboratory tests in a 10 percent sulphuric acid solution at 150 deg. F. showed that ammonium sulphate additions of 15 percent by weight reduced metal losses on Type 316 to a negligible amount. Type 316 is frequently used in ammonium sulphate saturators, where large amounts of sulphates are present.

In many instances, where sufficient amounts of inhibiting salts or acids are present with sulphuric acid, Type 304 has been found to be satisfactory. Tanks for certain chrome plating solutions containing small amounts of sulphuric acid have been made of Type 304. Where brass pickling solutions have copper sulphate added to the sulphuric acid bath, tanks, conveyors and pumps of Type 304 have frequently been used in these applications.

In the sulfonation of vegetable and animal oils, sulfonating tanks, heating coils and pipe have employed Type 316 satisfactorily where there is no dilution of the concentrated 66 deg. Be. acid.

By far one of the most important stainless steel applications involving sulphuric acid is that of nitration operations where a mixture of sulphuric acid and nitric acid is employed. Type 316 is usually more satisfactory for handling these mixed acids although Type 304 is sometimes used, depending upon the ratios of the two acids, dilution and temperature involved. Stainless steels have been used for car tanks, storage tanks and the actual nitration equipment such as kettles, pipe and fittings and pumps where the mixed acids are used.

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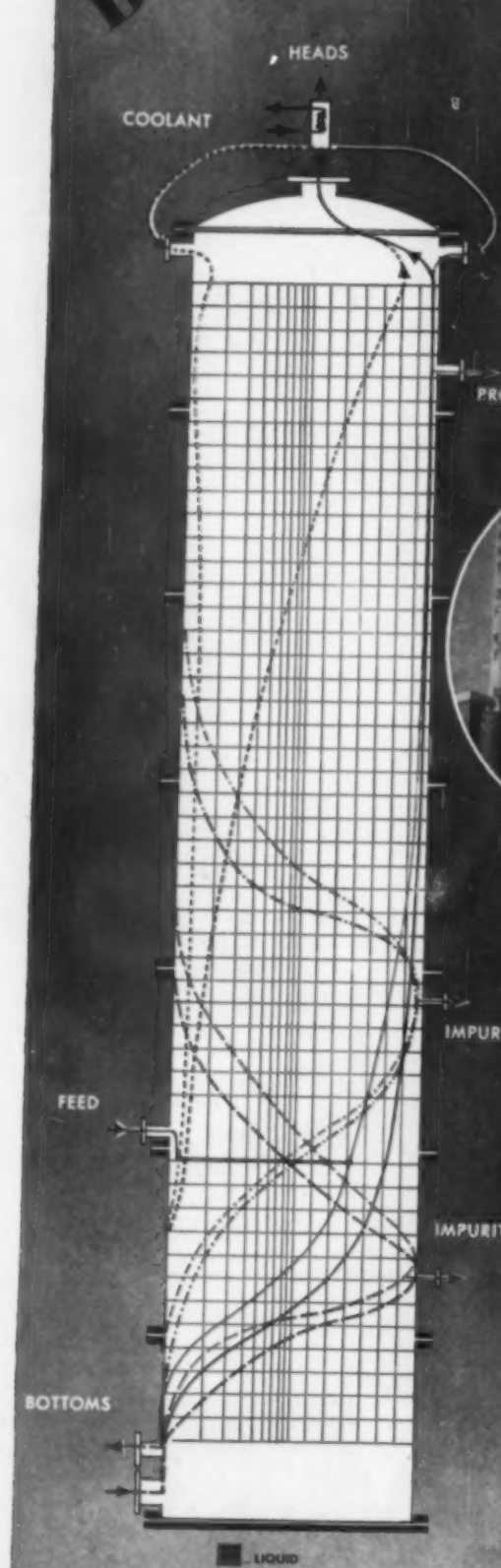

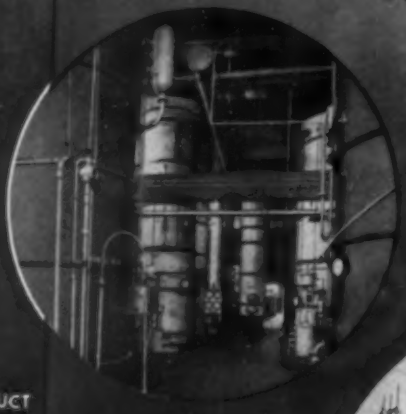

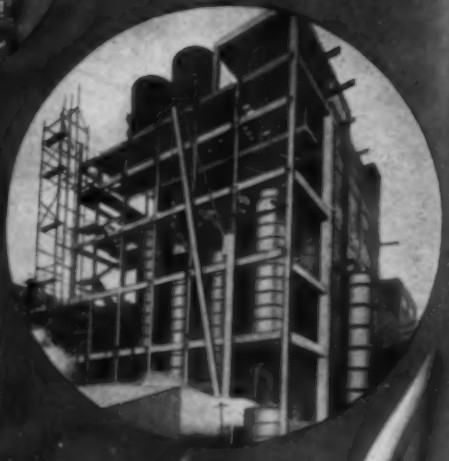

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FROM THE LOG OF EXPERIENCE

Dan Gulloben, ENGINEER

THE GREAT BATTLE between corn farmers and processors on the one hand and H. W. Wiley and the sugar producers on the other over the right to the term "sugar" waged through a period of forty years. Wiley contended that the sugar manufacturers held prior right and that their product was a pure, unaltered, unadulterated extract of a product of nature ($C_{12}H_{22}O_{11}$), which through 3,000 years of service had acquired a favorable public reaction. Housewives ordered it by name.

On the other hand, according to Wiley, glucose ($C_6H_{12}O_6$) was a mutilation of nature's cellulose ($C_6H_{10}O_5$) and was therefore not entitled to the benefit of its competitor's trademark. The opposition argued that their product possessed comparable food value, looked like sugar, tasted like it, and by Jove it was sugar. Moreover, theirs was the very same product into which sugar had to be converted in the stomach before it was assimilable. Sucrose Champion Ware urged that the best way to avoid prejudice against "chemical sugar" was to let nature produce it in the stomach; then at least there would be no clash with the Pure Foods and Drugs Act.

NOW CONSIDER that intelligent little bird, the honey bee. She is not equipped with a sugar breaker and must therefore store her fuel in the shape of uncrystallizable liquid invert. She loads her "pocket" with nectar, mostly sucrose of 25 Brix (25 lb. of sugar for 100 of sirup), transports it to the comb, and adds a little invertase of her own production to invert the sucrose. Then she fans the thin liquid with her wings to evaporate the liquid to 75 Brix and finally seals the comb and adds a shot of antiseptic from her stinger. The thing that impressed Wiley was the fact that when there was a shortage of the nectar crop, the bee prefers sugar which is rationed to her by a provident keeper. She has the facilities for inverting and prefers to do it herself to secure the alternate levulose.

The rest of the story, that is the transport of the sugar, rather promotes James Dole's propaganda. The bee's pocket is built like a tanker fitted with a pump but no hoisting gear for solids. Accordingly, in her wisdom, she picks up a pocketful of water, disgorges it onto the sugar crystals, and then lingers until the water melts the sugar to attain a Brix of 25. Dole is now urging sugar producers to take pattern and purify the juice in the tropics with ion exchange and transport it in tankers to the refinery. Anyhow, in Wiley's fight the argument became a succession of "It is, it isn't, it is, it isn't." Logic and comedy ad infinitum until Congress settled the row by an amendment to the Pure Food Law in 1926. The winner, corn sirup.

LEGALLY the fight is over but the salesmen and the advertisers have not yet been informed of it. The designer of advertising for articles of the household requires skill in the art of customer appeal. It is not so essential to possess acquaintance with the technology of the product whose merits he is commissioned to glorify provided only that he is informed about certain outstanding characteristics. He can fill in from his imagination and can cover a large field by implication to impress Mrs. composite housewife. Now, there is nothing better for the man who needs sugar in the blood quick than glucose and the needle. However if he has a little time it is pleasanter to take it with a bowl of strawberries. Neither the so-called "energy-sugar" nor sucrose has any advantage in speed. It is a fact that glucose is the only sugar that the bloodstream can accept. However there is present in the stomach a catalyzer that inverts sucrose into glucose almost instantly. This catalyzer absorbs no effort and is an absolute analogy to perpetual motion. The customer need be guided solely by his predilection, the price per unit of sweetening effect and his diabetic tendency. The diabetic's torment will be proportionately less in extent with two ounces of sucrose than with the sweetening equivalent of three ounces of dextrose. The "D" that the pharmacist prefixes before the glucose enhances the price but not the effect. Preserve manufacturers claim superiority of sucrose for certain fruits while for others dextrose produces a better "texture." Both dextrose and sucrose have their individual fields. The overlapping field in the middle is the one that creates the high blood pressure in the advertising department. If the customer saturation point for a product is attained by a production of a million lb. the traffic will bear a price that produces profit. Then along comes some fellow with a new factory having a capacity of 5,000 lb. The customers do not need any more but they can't resist a bargain and so the 5,000 lb. of surplus depresses the price for the entire industry.

POPULAR PREJUDICE against glucose in the early days derived from the name rather than the quality. Corn sugar's value as food had been established through long use. Additional assurances were promulgated through reports from eminent research scientists like Ira Remsen. The great American addict on the average likes to smother his flapjacks in sirup of lower sweetness. He could obtain the desired effect with less extravagance by a thin film of sweeter sirup but he wishes to see a swimming pool in his plate. A famous sirup marketer of New York volunteered that "molasses blending is an art not acquired from books." A paragrapher retorted that "the same could be said of poker. But Louisiana poker is regarded as a very square game as compared with molasses blending." This same manufacturer, even as late as 1922, lauded the efficiency of sugar as food but averred that it could be used to excess. "On the other hand," said he, "the natural sugar in the molasses is taken up by the body without undue strain and it can be used in practically any quantity."

In 1907 it was alleged that "a Chicago manufacturer of maple sirup used Nebraska corn glucose with an extract of hickory bark and corn cobs," and that his "genuine Chicago-made maple sirup was wrapped in old weather-stained newspapers brought from vil-

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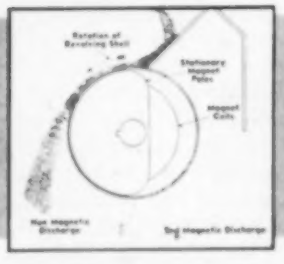

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lages in New Hampshire." The longshoreman or the street urchin doesn't care a whoop what his sirup is made of just so it's sweet and in large quantity. The householder is attracted by the glamorous label with the kindly grandmother or with the maple trees and the busy family tapping for sap. The Pure Food Law requires an honest admission of the contents, the learning of which about 40 years ago was accompanied by considerable distress to unscrupulous manufacturers.

THE OXNARD Construction Co. built five beet sugar factories around the turn of the century, all of which are still in operation, although one has been moved to a new location. They accepted contracts on a cost-plus basis only and this became unpopular. Their last proposal concerned a factory for East Tawas, Mich., in 1903. The owner announced that the contract would go to Kilby on a lump sum, as he was opposed to a proposition based on "Yes, we'll take the contract. You just keep on sending money until we tell you to stop."

SMYSER'S SYSTEM of packaging sugar continued as the monopoly of John Arbuckle and no large scale effort was made to follow it until Ben Oxnard rediscovered the advantages of the paper bag in 1936 (*Chem. & Met.*, April 1946, p. 231). To meet competition the "American" developed small cotton bag filling and cardboard cartons, both of which are still on the market, the latter being especially suited for powdered and brown sugars. By 1905 the refinery-filled consumer packages were cutting into the grocer's business of filling his own by hand. The hands did not cost much and besides "they were there anyhow." The grocer packed in any amount from two pounds to twenty-five or in quantities measured by ten, twenty-five and fifty cents or a dollar. He guarded store packaging jealously as a perquisite of his trade. The resistance to refinery packaging was voiced by a communication from a hinterland grocer to his trade journal in 1905. Said he, "How do you expect the grocer to endorse the cartoned sugar when the only chance he has to make a profit on the staple, namely by skimping the weight, was nipped by the use of cartons?" Hand filling at the store caused a loss of sugar and a cost of 40¢ per hundredweight for time, bags and twine.

The factory packed container identifies the producer and reassures the buyer. In sections where there was demand for both cane and beet sugar, the grocer had two barrels. After the heads were removed there was no identification.

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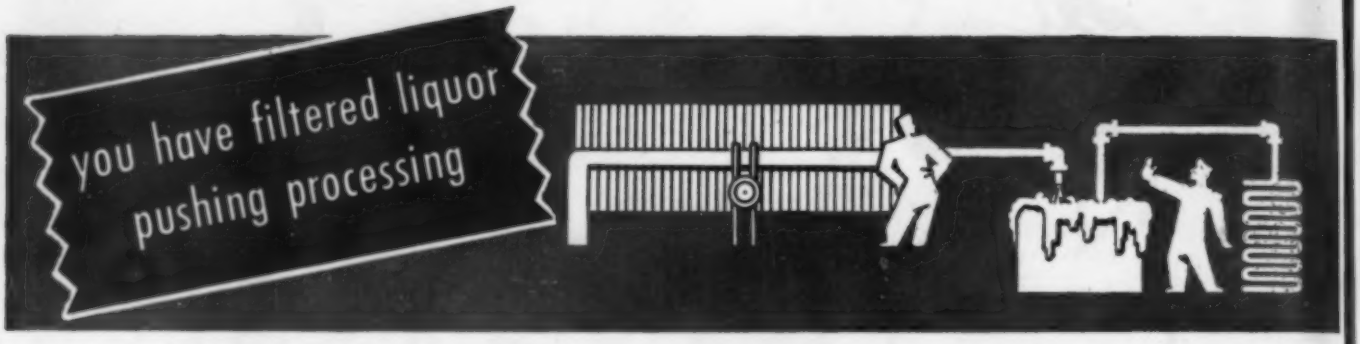

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NAMES IN THE NEWS

Man of the Month

C. A. Thomas

Dr. Charles Allen Thomas, executive vice president and technical director of Monsanto Chemical Co., received the 1948 gold medal of the American Institute of Chemists on May 7 in New York. The award was made in recognition, not only of Dr. Thomas' work in the development of atomic energy and his leadership in research, but also for his administrative ability and his encouragement of basic research.

Dr. Thomas, one of the key figures in the development of atomic energy, was born in Scott County, Ky., Feb. 15, 1900. He was graduated from Transylvania College and Massachusetts Institute of Technology with degrees of B.A., M.S. and D.Sc.

In 1923 he joined the General Motors Research Corp. and worked on anti-knock materials and bromine from sea water. Later he was transferred to the Ethyl Gasoline Corp. In 1926 he and Dr. Carroll A. Hochwalt organized the consulting firm of Thomas & Hochwalt Laboratories.

In 1936 the laboratories were acquired by Monsanto and Dr. Thomas became central research director. In 1945 he was made vice president and technical director; a year ago he was elected executive vice president.

During the war Dr. Thomas was one of the principal scientists in the development of the atomic bomb, having had charge of final purification and metallurgy of plutonium. He also had a leading role in catapult rocket research and other developments. Dr. Thomas was one of the small group of scientists to receive the Medal for Merit from Secretary of War Patterson in March 1946.

Dr. Thomas is president and a director of ACS, as well as a member of AAAS, AIC, AIChE and other chemical and engineering organizations.

Ernest J. Pieper has been appointed manager of chemical research for the Armstrong Cork Co. following the retirement of **C. C. Vogt.**

Charles J. Krister has been appointed general marketing and field development supervisor of the Du Pont company's new agricultural product development section, a part of the Grasselli chemicals department.

D. J. Catalano has been appointed chief control chemist for Ortho Pharmaceutical Corp., Raritan, N. J.

R. G. Landis

E. R. Hollinger

R. G. Landis, director of the Sherwin-Williams Co.'s Oakland laboratory has been appointed general supervisor of the company's entire technical operations on the Pacific Coast. **E. R. Hollinger** has been named director of the Los Angeles laboratory.

George Oenslager of Akron has been awarded the first Charles Goodyear Medal of the Division of Rubber Chemistry of the American Chemical Society. The award, established this year to honor rubber chemists for outstanding achievements, was presented April 22 in Chicago.

Ray P. Dinsmore, vice president in charge of research for the Goodyear Tire & Rubber Co., on June 25 will receive the Colwyn Gold Medal for 1947. The medal is given by the Institution of the Rubber Industry for conspicuous services of a scientific or technical character, having an important bearing upon the rubber industry.

R. P. Dinsmore

C. W. Walton

Charles W. Walton, assistant to the vice president in charge of manufacturing, has been named to head the newly established market research and marketing development division of the Minnesota Mining & Manufacturing Co., St. Paul, Minn.

Thomas L. Hines, manager of the cellophane division, retired March 31 after almost 33 years of service with E. I. du Pont de Nemours & Co.

Robert F. Kincaid, John J. Mulloy and **Rosetta M. Kline** have joined the staff of the Dow Chemical Co.

Wheeler G. Lovell, formerly assistant head of the organic chemistry department of the General Motors Research Laboratories, has joined the staff of Ethyl Corp.'s Detroit Research Laboratories.

Leonard J. Edwards has joined Glyco Products Co., Natrium, W. Va., as chemical engineer.

William T. Wood has been appointed director of production of the nylon division of the rayon department of the Du Pont company succeeding **W. E. Gladding,** who has been transferred to special assignment for the

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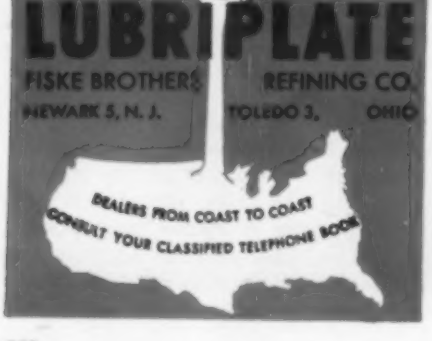

nylon division management. **M. G. Jones**, manager of the Waynesboro, Va., plant has become director of production of the acetate division, and **Thomas Taylor**, of the Spruance plant, Richmond, Va., succeeds Mr. Jones at the Waynesboro plant.

Charles A. Wight, vice president of Bankers Trust Co., has been elected chairman of the executive committee of Freeport Sulphur. Mr. Wight, who is also a director of Freeport, is a director of Grumman Aircraft Engineering Corp. and of McGraw-Hill Publishing Co.

F. L. LaQue has been elected president of the National Association of Corrosion Engineers for the 1948-9 term.

B. J. C. van der Hoeven has been appointed vice president in the chemical division of Koppers Co., Inc. He also will retain his duties as assistant general manager of the company's chemical division.

B. van der Hoeven

M. S. Argruss

M. S. Argruss has been appointed director of the research and development department of the Precision Scientific Co., Chicago.

Harold Hoyle, formerly of the safety department of the Dow Chemical Co., will take up new duties as an industrial hygienist in the company's biochemical research laboratory shortly. Because of his knowledge of the plant and his long experience, Mr. Hoyle's duties will include industrial hygiene surveys.

James A. Wilson, plant manager at the headquarters of Monsanto Chemical Co. Merrimac division at Everett, Mass., has been appointed production manager for the division. Mr. Wilson was succeeded as plant manager by **Russell L. Miller**, plant superintendent.

Harold E. Mahony, assistant plant manager, has been named manager at the Stonewall plant of Merck & Co. in Elkton, Va., to succeed **John H. Holcomb**, who resigned to take charge of a family business. **John N. Millar**, chief engineer, has assumed the addi-

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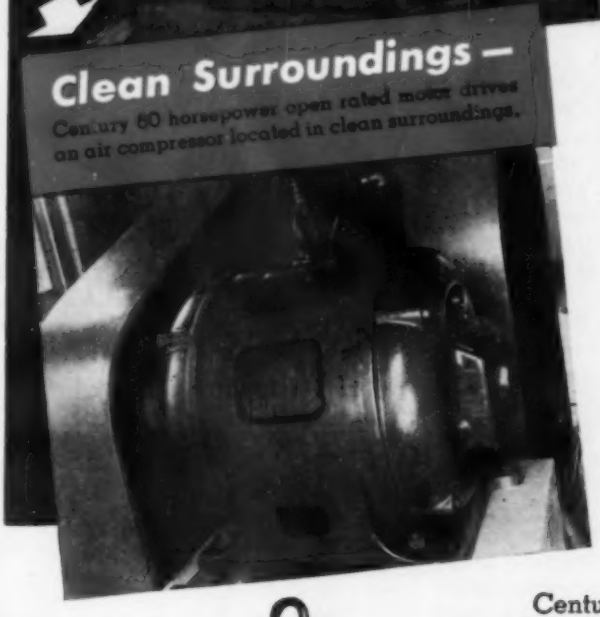

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tional post of assistant plant manager, and **Alvin C. Sapp** becomes superintendent of manufacturing.

William S. Thurber is now in the styrene polymerization laboratory of the Dow Chemical Co., Midland, Mich., after receiving his M.S. degree in organic chemistry from Michigan State College in February.

Ulick R. Evans and **John M. Pearson** were recipients of the 1948 awards of the National Association of Corrosion Engineers. Dr. Evans has received the Willis Rodney Whitney Award in Corrosion Science and Dr. Pearson the Frank Newman Speller Award in Corrosion Engineering at the Association's Annual Banquet last month in St. Louis.

J. A. Britton, Jr.

O. V. Tracy

John A. Britton, Jr. has been elected as president of Enjay Co. Inc., chemical products marketing affiliate of Esso Standard Oil Co. **O. V. Tracy,** assistant manager of Esso Standard's Chemical Products Department, has been elected a director of Enjay.

T. Robert Sandberg has been named works manager by Cutter Laboratories, Berkeley, Calif. He was formerly superintendent of penicillin production, and prior to that, superintendent of chemical production.

Curran S. Easley and **Hugh Black** have formed a business association, specializing in materials handling and power transmission equipment. Offices are at 29 Pendleton St., Greenville, S. C.

J. V. Pennington has been named director of the projected Houston, Tex., units of the Southwest Research Institute and Foundation of Applied Research at San Antonio, Tex.

Loyal Clarke is now in the process division of Day & Zimmerman, Philadelphia. He was formerly in the Bishop, Tex., plant of the Celanese Corp. of America.

Arlington Kunsman has been appointed manager of the cellophane division of E. I. du Pont de Nemours & Co. to succeed **Thomas L. Hines,** who

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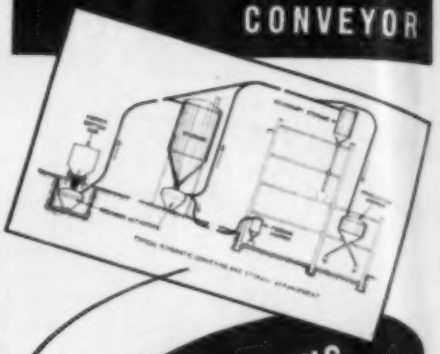

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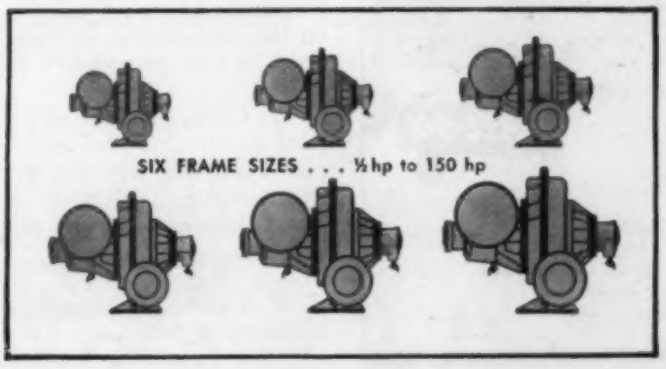

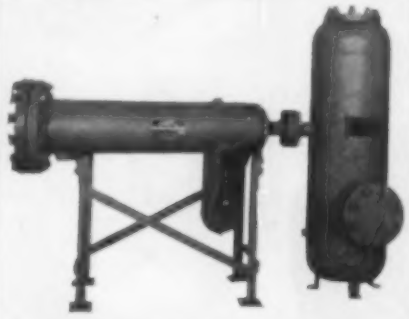

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has retired. **J. Edward Dean** is now assistant manager succeeding Mr. Kunsman.

William M. Murray, Jr., has been appointed acting director of Southern Research Institute of Birmingham, Ala., until such time as the Trustees select a permanent successor to Dr. Wilbur A. Lazier, resigned.

T. S. Nichols

G. W. Dolan

Thomas S. Nichols has been elected president and chief executive officer of Mathieson Chemical Corp. **George W. Dolan**, formerly president, was elected chairman of the board. **A. U. Fox**, former chairman, resigned. **John C. Leppart** was elected vice president.

Theodore R. Corbett has been appointed manager of Carter Oil Co.'s manufacturing department. Last year he became manager of the company's manufacturing work at Billings and Cut Bank, Mont., and Newcastle and Lovell, Wyo.

Carl Nielsen, associate director of research at Abbott Laboratories, North Chicago, Ill., has been made a knight of the Order of Dannebrog by Frederick IX, King of Denmark.

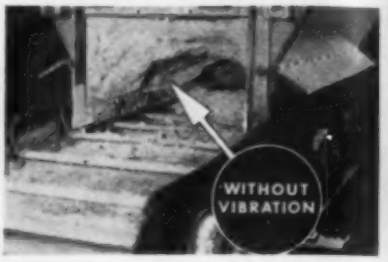
S. Carroll Young has been appointed to the post of industrial relations manager in the General Aniline Works Division plant of General Aniline & Film Corp. at Linden, N. J. The appointment was made as part of reorganization measures made necessary by the death of **James M. Cunningham.**

Herbert Leaderman has been appointed to the division of organic and fibrous materials, National Bureau of Standards, where he will do research on the fundamental mechanical properties of high polymers.

S. W. Clark, manager of the agricultural department of Texas Gulf Sulphur Co. at Houston, has been elected chairman of the newly organized Texas Commercial Agriculturists' Council.

C. E. Finney, Jr., has been elected president of Salt Lake Refining Co. and Salt Lake Pipe Line Co., both

Having Trouble with Stubborn Materials?



Arching-over and plugging-up in bins, hoppers and chutes?

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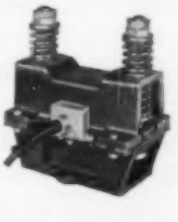

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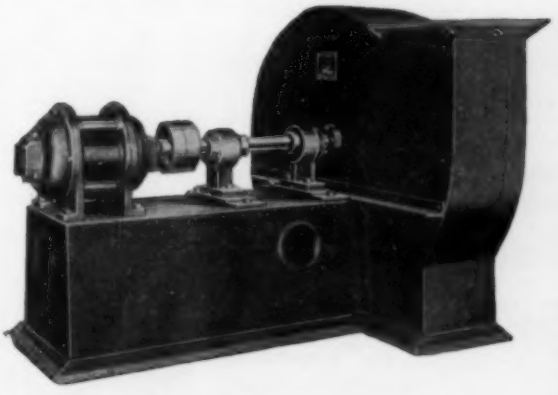

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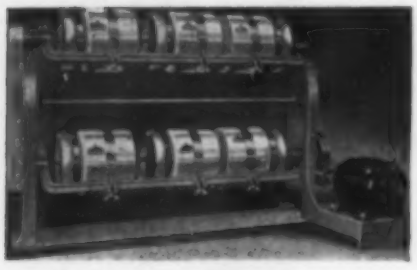

FOR THE LABORATORY

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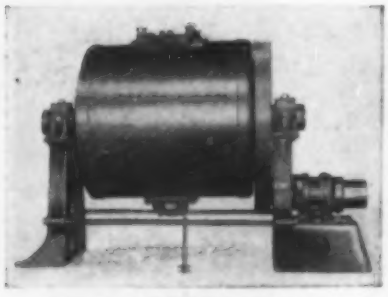

FOR PILOT PLANTS

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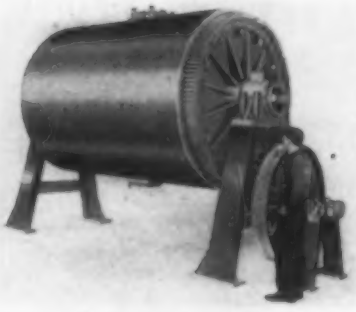

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Herbert G. Hard, Jr., who was formerly with Alabama By-Products Corp. has joined Southern Research Institute, Birmingham, Ala. He will be connected with the plastics and applied chemistry division.

Marvin J. Udy of Niagara Falls has been awarded the 1948 Jacob F. Schoellkopf Medal of the Western New York Section of the American Chemical Society for his contributions to the refining and utilization of chromium. Presentation was made May 8.

M. J. Udy

C. F. Bonilla

Charles F. Bonilla has been appointed professor of chemical engineering at Columbia University's School of Engineering. Dr. Bonilla, who is now professor of chemical engineering at Johns Hopkins University, Baltimore, will direct research and teach in the field of chemical engineering thermodynamics.

Prescott Sandidge has been appointed assistant director, with responsibility for administrative matters, at the central research department of Monsanto Chemical Co., Dayton. He was executive director of the Clinton National Laboratories.

W. S. Traylor has been appointed resin supervisor at the Hercules Powder Co.'s new synthetic resin plant at Burlington, N. J. He formerly held a similar position at the Hercules plant at Mansfield, Mass. **W. W. Becker**, formerly supervisor of resin production development, has been named to succeed Mr. Traylor at Mansfield.

Alvin C. Wiese has been elected chairman of the Washington-Idaho border section of the American Chemical Society. Dr. Wiese is head of the department of agricultural chemistry at the University of Idaho.

Norman W. Krase has returned from London after several years of service as European technical representative in the foreign relations department of E. I. du Pont de Nemours

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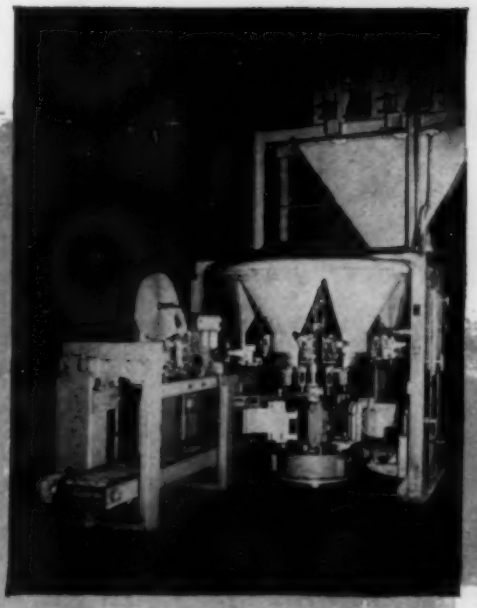

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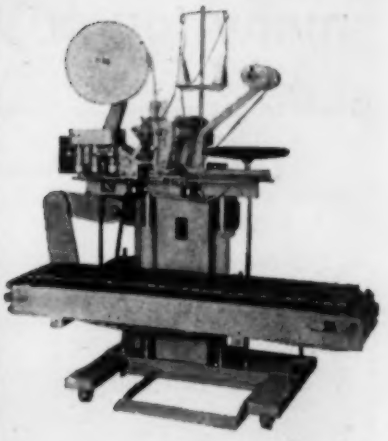

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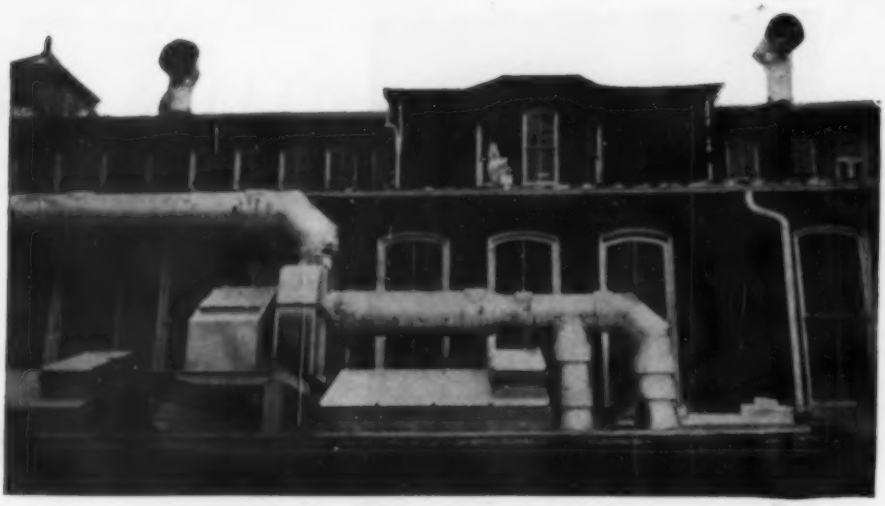


Here's a practical solution to many tough VENTING PROBLEMS

Plant engineers in many industries are finding the answer to tough venting problems—and high venting costs—in Transite Industrial Vent Pipe.

The reason: this asbestos-cement product is highly resistant to many corrosive fumes, vapors, dusts and gases. Its ability to stand up under corrosive conditions cuts frequency of replacements, results in important economies in plant maintenance.

EASILY WORKED: Transite can be cut and drilled on the job.

In addition, Transite Industrial Vent Pipe has a smooth inner surface that assures minimum frictional resistance—means economical operation.

This pipe has many other practical advantages. Relatively light in weight, it is easily installed. It can be cut and drilled on the job. Rustproof, it needs no painting whether used indoors or out.

Transite Industrial Vent Pipe is made in a range of sizes up to 36" in diameter and is readily adaptable for use as vents, ducts and stacks. A full line of Transite fittings provides a venting system which is corrosion-resistant throughout.

ADAPTABLE: A complete line of Transite fittings meets a wide range of job requirements.

For further information write Johns-Manville, Box 290, New York 16, New York. Simply ask for Data Sheet Series DS-336.

JM PRODUCTS

Johns-Manville TRANSITE Industrial Vent PIPE

& Co. His new duties will be with the development department in Wilmington. **Charles J. Harrington** has been appointed to fill the London position. Dr. Harrington was on the staff of the Neoprene plant in Louisville.

Brooks F. Smith has been named assistant chief of the test division, Chemical Corps Technical Command, Army Chemical Center, Md.

George O. G. Löf is now technical director at the Denver chemical plant of Colorado Fuel and Iron Corp. He was previously professor of chemical engineering at the University of Colorado.

Earle W. Webb has resigned as chairman of the board of Ethyl Corp. after an association of nearly 23 years with the company.

Kenneth E. Mulford has been appointed assistant general manager of the industrial chemicals department of Atlas Powder Co., Wilmington.

Frederic Matthews has been appointed director of research for the Merrimac division of Monsanto Chemical Co., Everett, Mass. Dr. Matthews succeeds **W. S. Wilson,** authority on paper chemicals, who will be free to devote full time to special research projects in the paper chemical industry and allied fields.

J. Philip Evans has been appointed assistant to the manager of research and development in the research and development department of the Pennsylvania Salt Manufacturing Co. The other new additions include **Clifton R. Neumoyer,** senior research chemist in the research division; **Joseph Simkin,** research chemist, special products division; and **Charles A. P. vonHemert,** junior chemical engineer, development division.

OBITUARIES

Henry J. Kasch, Sr., 63, a pioneer in the plastic molding industry, died in Dayton March 19.

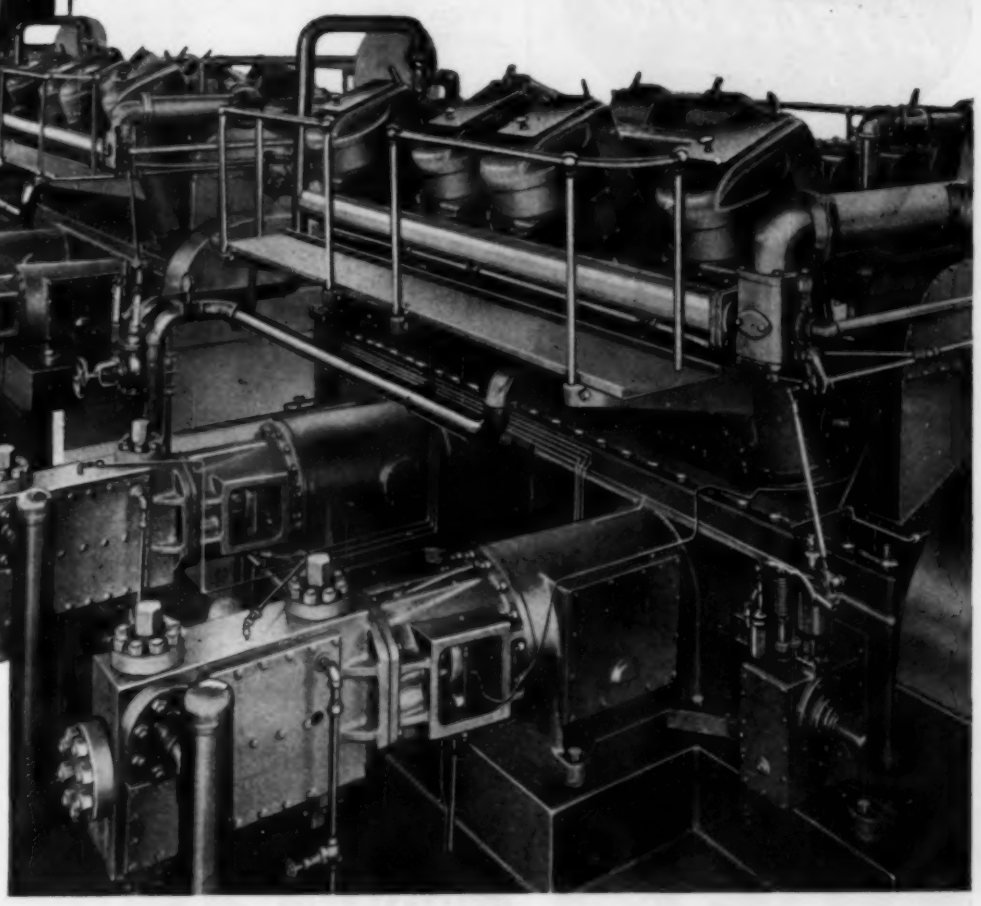
Richard B. Feibelmann, 64, international figure in the textile and paper industries, died in Port Jervis, N. Y., March 25.

James H. Herron, consulting engineer and president of James H. Herron Co., died in Fort Lauderdale, Fla., March 29.

Milton A. Maas, 76, president of Maas & Waldstein Co., died in Stamford, Conn., March 30.

4-CYCLE GAS-ENGINE COMPRESSORS

V-ANGLE



Six 800-hp Type KVG gas-engine-driven compressors on recycling service.

4-Cycle DEPENDABILITY
" " LOAD FLEXIBILITY
" " FUEL ECONOMY
" " LUBE-OIL ECONOMY
" " SIMPLICITY
" " CONSERVATIVE RATING

Whether the load is heavy and continuous . . . whether the pressures are steady, variable, or surging . . . whether the required speed is constant or fluctuating.

You **get these advantages in Ingersoll-Rand Gas Engines and Gas-Engine Compressors . . . Sizes 75 to 1200 horsepower**

Ingersoll-Rand

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78-6

If You Need
TANKS
Then You Need
LITTLEFORD

Tanks are so vitally important in your business that the greatest economy is in the very best—Littleford. We fabricate any kind, to your specifications: agitator, plain, jacketed, pressure, mixing or storage. Work in stainless steel, Monel, nickel, Inconel, aluminum, etc. At Littleford you get all the skill, facilities and engineering knowledge acquired over 66 years. Next time, make it Littleford!

FABRICATORS OF PLATE AND SHEET METALS
LITTLEFORD
LITTLEFORD BROS., INC.
428 E. Pearl St., Cincinnati 2, Ohio

INDUSTRIAL NOTES

Portland Cement Association, Chicago, will build a large research laboratory 15 miles north of Chicago.

Carpenter Steel Co., Reading, Pa., has promoted Omar V. Greene from assistant general sales manager to manager of product development. H. Sturgis Potter has been made sales manager.

Chas. Pfizer & Co., Inc., Brooklyn, N. Y., has elected John L. Smith, president, and George A. Anderson, chairman of the board. Twelve directors were re-elected.

E. I. du Pont de Nemours & Co., Wilmington, has expanded its nitrogen products section. They have appointed M. N. Crady to represent the section on the Pacific Coast.

Libbey-Owens-Ford Glass Co., Toledo, has named Robert C. Hesselbart technical service representative for the company's glues and industrial resins.

Babcock & Wilcox Co., New York, has elected A. G. Pratt, former president, chairman of the board. Alfred Iddles succeeds him as president.

Chemical Corp. of Colorado, Denver, has appointed Daniel E. Bonnell as vice president in charge of sales.

Allen-Bradley Co., Milwaukee, Wis., has appointed James M. White to the production management staff.

Pittsburgh Plate Glass Co., Pittsburgh, has appointed A. I. Pruett general manager of their subsidiary, Thresher Paint and Varnish Co., Dayton, Ohio.

Ferro Enamel Corp., Cleveland, has opened a new clay processing plant at Nashville, Tenn.

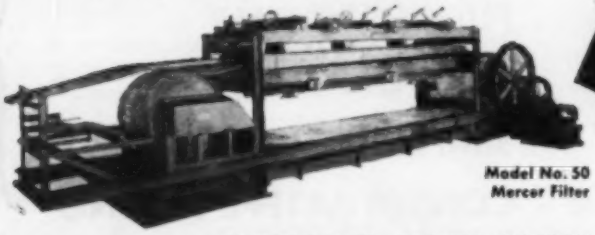
Hewitt-Robins Inc., Buffalo, has appointed the Penn Central Equipment Co. of Altoona, Pa., to distribute the products of the Hewitt Rubber Division.

Link-Belt Co., Chicago, has established a district sales office in Jacksonville, Fla. Robert L. Lowder is in charge of the office.

E. I. du Pont de Nemours & Co., Wilmington, has granted free licenses to 50 paint and lacquer companies for the manufacture of metallic finish

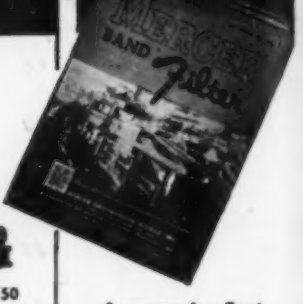
MERCER
BAND Filters
FILTRATION
WASHING · DRYING

Low-cost Efficient Continuous Suction Process



Model No. 50
Mercer Filter

WRITE FOR MERCER FILTERS BULLETIN No. 70



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Multiple washing zones. Evenly formed filtered cake. Varied thicknesses. Automatic cake discharge. Continuous filter medium cleansing. Low power consumption.

Arrange for Test
Mercer plant is equipped to conduct and report upon experimental tests made with samples of your materials. Inquire about this service.

"The Name that Carries Weight"

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REPRESENTED BY MERCER-ROBINSON COMPANY, INC.
30 CHURCH STREET, NEW YORK 7, N. Y.
Sales Offices in Principal Cities

ANACONDA

American

METAL HOSE

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

Throughout Canada:

THE CANADIAN FAIRBANKS-MORSE CO., LTD.

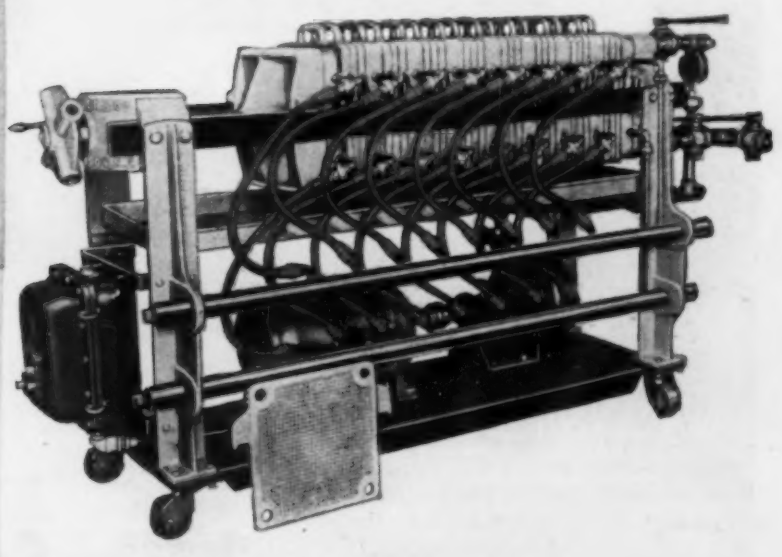
CONNECTOR PROBLEMS *Solved*

CUSTOM DESIGN COSTS NO MORE

RATHER THAN EXPERIMENT with your connector problems, you can profit by submitting them to American engineers. For we have been specializing in flexible metal connector problems for forty years.

American *designs* the connector to your exact requirements—complete with special end fittings attached—at no extra cost. Whether it's conveying steam, oil, water, other liquids, semi-solids or gases, there's a type of American Flexible Metal Hose or *Seamless* Flexible Metal Tubing designed for easy installation and long life.

American Seamless Flexible Metal Tubing—made from seamless bronze tube, corrugated for maximum flexibility—is standard in sizes ⅛" to 4" I.D. American Metal Hose, manufactured from continuous strips of brass, bronze, aluminum, steel and other metals in four spirally wound types—with joints packed or unpacked—is available in sizes ⅛" to 12" I.D. Write for literature. And feel free to consult our Technical Department at any time. 48297



Filter press made by T. Shriver & Company Inc., Harrison, New Jersey. Steam lines are ½" I.D. Seamless Flexible Bronze Tubing—designed by American.

From Any Angle ...It's WILLSON For Safety With Comfort

Style V3-84C

A FLARE FOR PROTECTION . . . Side wings on this metal-edged, easy-to-wear Protecto-Shield* give extra protection . . . deflects splashing liquids from face, head and eyes.

Style X41

FOR SPLASH-PROOF EYES . . . Rolled, resilient edges of this Over-All* rubber mask goggle hug facial contours to keep out chemical splash and metal spatter. Tops in comfort and protection.

Style No. 701

DOUBLE BARRELED PROTECTION . . . Two replaceable chemical cartridge filters highly effective against low concentrations of vapors; provide low breathing resistance. *Reg. U. S. Pat. Off.

For complete information on these products and their application, as well as many more eye and respiratory protective devices, get in touch with your nearest Willson distributor or write us direct.

GOGGLES • RESPIRATORS • GAS MASKS • HELMETS

DOUBLE WILLSON PRODUCTS INCORPORATED READING PA U.S.A.

126 Thorn Street, Reading, Pa., U.S.A.

which Du Pont markets as Duco Metalli-Chrome lacquer.

Brown Coating & Equipment Co., Wellston, Ohio, is now manufacturing equipment for the chemical trade.

Liquid Conditioning Corp., Linden, N. J., has built an addition to its plant to house its engineering department.

H. K. Ferguson Co., New York, has appointed Royal A. Stone chief engineer for the eastern district.

Johns-Manville Corp., New York, has appointed George Frankland as Chicago district manager. William S. Hough succeeds him as assistant district manager.

Fisher Governor Co., Marshalltown, Iowa, has appointed W. H. Kidd & Co. as district sales representative for the state of Virginia.

Foster Wheeler Corp., New York, has elected Martin Frisch a director of the corporation. Lee Allen Swem was elected a vice president.

Kennedy Valve Mfg. Co., Elmira, N. Y., has elected Charles F. Kennedy as president.

Schwarz Laboratories, Inc., has elected Robert Schwarz chairman of the board. Herbert A. Schwarz has been elected president.

Innis, Speiden and Co., New York, has named Charles H. Berle assistant works manager of its Isco Chemical Division, Niagara Falls, N. Y.

Libbey-Owens-Ford Glass Co., Toledo, has appointed Oliver P. Clipper to the coating compound sales force of the Plaskon Division.

Iron & Steel Products, Inc., Chicago, has appointed Frank M. Sweeny sales representative in the Baltimore district.

Baker Ice Machine Co., South Windham, Me., has appointed Lee C. Leslie district manager of the St. Louis office.

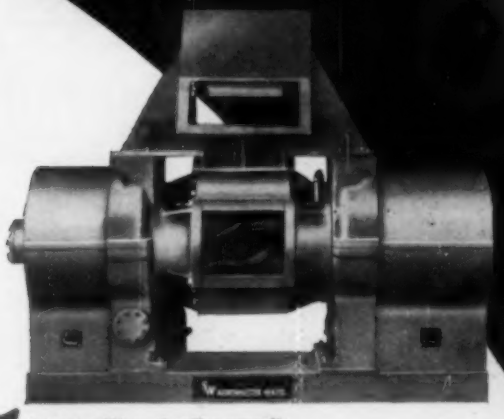
Carpenter Steel Co., Reading, Pa., has named J. Heber Parker chairman of the board and has elected R. V. Mann vice president in charge of sales.

Northeastern Wood Utilization Council, has announced a conference on bark, its chemistry and utilization, which will be held in Boston, Mass.,

Struthers Wells design and build a complete line of

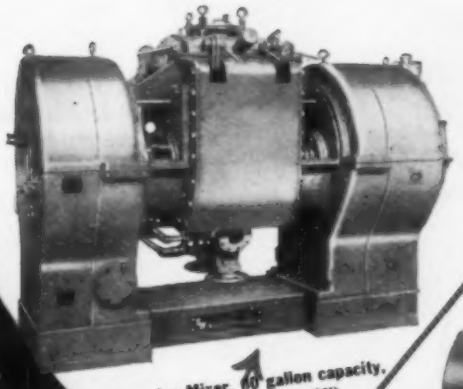
MIXING *machines*

for extremely difficult processing or laboratory test operations

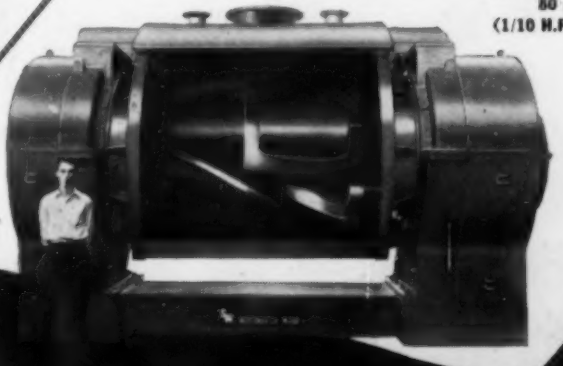


Intensive Mixer, 5 gallon capacity, 50 H.P. (10 H.P/GALLON)

Kneading Mixer, 800 gallon capacity, 80 H.P. (1/10 H.P/GALLON)



Dispersion Mixer, 60 gallon capacity, 60 H.P. (1 H.P/GALLON)



The complete line of MIXING EQUIPMENT designed and built by STRUTHERS WELLS is the result of many years of experimentation and development by some of the most experienced process equipment engineers in America—to meet the increasing demand for larger, stronger, more efficient types of precision mixing equipment for heavy and light duty operation at lower production costs.

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CORPORATION
Northmaster Division
Plants at
WARREN, PA. and TITUSVILLE, PA.
Offices in Principal Cities

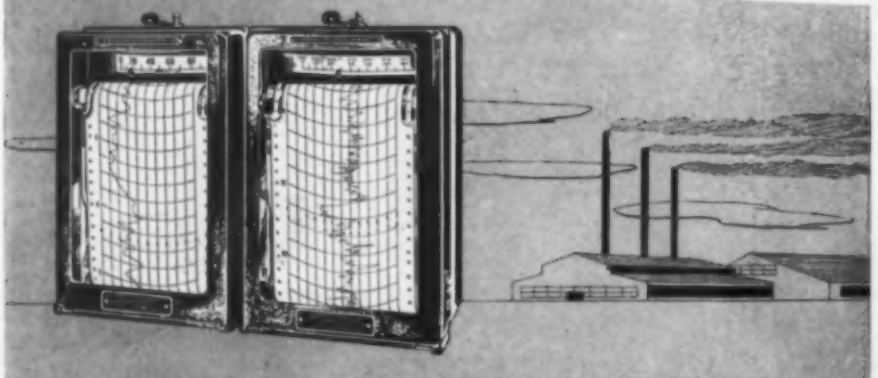
9 out of 10 industries Need Bendix-Friez Wind Recorders for Smoke Abatement Installations

Equipment for smoke and fume control is not complete without permanent records of wind-speed and direction. Write us about Aerovane.*

*TRADE MARK

Aerodynamic transmitter is easy to install and modern in design.

Wind speed, wind direction permanently recorded indoors.



FRIEZ INSTRUMENT DIVISION
OF BENDIX AVIATION CORPORATION
Baltimore 4, Maryland

Bendix AVIATION CORPORATION

with the cooperation of the Massachusetts Institute of Technology on Sept. 17, 1948.

Tenney Engineering, Inc., Newark, N. J., has appointed Sam C. Moncher engineering sales representative for the metropolitan New York and northern New Jersey area.

Southern Alkali Corp., Corpus Christi, Tex., has appointed Donald C. Jolly manager of the order and service department.

Diamond Alkali Co., Cleveland, has appointed A. H. Ingley vice-president in charge of operation for its eleven chemical plants. M. O. Kirp has succeeded him as general manager of the Painesville plant. W. A. Crichley has been appointed assistant controller.

Wheelco Instruments Co., Chicago, has named J. P. Cantor district manager of the new Cleveland district office. The Washington, D. C., office has been moved to 2285 Rhode Island Ave. Robert Smith is in charge.

Mason-Neilan Regulator Co. has appointed E. Putnam Head manager of their Atlanta office.

Standard Brass & Manufacturing Co., Beaumont, Tex., has been made southwestern distributor for the Parker Appliance Co., Cleveland.

International Trade Mart, New Orleans, La., will build a new world market place to be completed July 1.

Hooker Electrochemical Co., Niagara Falls, has promoted John P. Edwards to the sales development department.

Commercial Solvents Corp., New York, has appointed Frank E. Dolian assistant manager of the technical service division. A. M. Cooke will cover the New England territory.

McKesson & Robbins, Inc., Bridgeport, has established a bulk chemical distributing department in the Chicago division. Manager of the new department is Lee Enberg.

C. K. Williams and Co. and eight of its subsidiaries have been consolidated. Executive offices are located at East St. Louis, Ill.

Chemical & Process Machinery Corp., New York, has appointed John E. Riviere of Montreal their sales representative in the Canadian area.

Paraffine Cos., Inc. has named Irvin Hovgaard manufacturing manager of

From **SHELL CHEMICAL** ... in tank car quantities

A NEW SUPERIOR

Alkylated Aromatic

for the manufacture of detergents with exceptional wetting and emulsifying properties

If you work with detergents of the alkyl aryl sulfonate type, you may be interested in Shell Chemical's new alkylated aromatic. This material offers you an intermediate for the manufacture of detergents with the superior wetting, emulsifying, suspending and dispersing properties necessary in a fine product. In addition, *it can bring you new opportunities to increase your manufacturing efficiency.*

This new alkylated aromatic is both light in color and free from odor ... of uniform quality and high purity.

Why not examine its possibilities in your own plant?

TYPICAL PHYSICAL PROPERTIES

Average Molecular Wt.	260
Boiling Range, °C	290 - 325°
Specific Gravity, 20/20 °C	0.8690 - 0.8715
Color, Platinum-Cobalt	140 max.
Flash Point, °F	290
Refractive Index, n_D^{20}	1.4900 - 1.4910

Among the many other Shell Chemical products are Tertiary Butyl Alcohol, Diacetone Alcohol and Acrolein.

A letterhead request to any of the Shell Chemical district offices listed below will bring you complete technical information and a sample.

SHELL CHEMICAL CORPORATION

100 Bush Street, San Francisco 6 • 500 Fifth Avenue, New York 18
Los Angeles • Houston • St. Louis • Chicago • Cleveland • Boston • Detroit

Eleven tons moved from truck to third floor in *90 minutes*

with a **DRACCO**

PNEUMATIC CONVEYOR

Consult DRACCO Engineers

The outstanding merit of DRACCO Pneumatic Conveyors is ECONOMY. They save time and labor—and in many cases eliminate a dust hazard. In the above illustration 11 tons of material were moved from truck to bin on the third floor in 90 minutes by one man. If you move chemicals, grains or granular materials, why not give consideration to material handling? In many plants DRACCO Engineers have made large savings. It will pay to consult them and obtain the advantage of more than 30 years experience in material handling.

For Further Information Write

DRACCO CORPORATION

4071 E. 116th St., Cleveland 5, Ohio *New York Office*- 130 W. 42nd St.

DUST CONTROL EQUIPMENT

PNEUMATIC CONVEYORS • METAL FABRICATION

their eastern division. Succeeding him as manager of the Emeryville plant is former manufacturing division auditor J. B. Lee. T. L. Melgaard has been appointed assistant plant manager.

Dearborn Chemical Co., Chicago, has appointed Earl J. Goris advertising manager.

United States Steel Corp. has appointed Thomas E. Bertelsen district sales manager of the Indiana-Michigan area of its subsidiary, the Universal Atlas Cement Co.

Girdler Corp., Louisville, Ky., has appointed K. G. Holdom eastern representative for the gas processes division.

Air Reduction Co., Inc., has elected Charles S. Munson chairman of the executive committee.

Continental Ore Co., New York, has appointed H. S. Ten Eyck head of its newly organized chemical division.

L. Sonneborn Sons, Inc., New York, has placed Robert J. Sandke in charge of West Coast sales of its White Oil & Petrolatum division.

United States Steel Corp., Chicago, has made J. Donald Rollins chief engineer of the Gary works of its subsidiary, Carnegie-Illinois Steel Corp. He succeeds Sigurd Landen who has been promoted to chief engineer of the Chicago district.

Goodyear Tire & Rubber Co., Akron, has appointed Karl J. Leary Chicago representative for the Airfoam department, chemical products division.

United States Steel Corp., Chicago, has appointed Fred L. Warnke comptroller of the United States Steel Supply Co. He succeeds C. B. Vernooy who has been appointed comptroller of the Geneva Steel Co., another subsidiary.

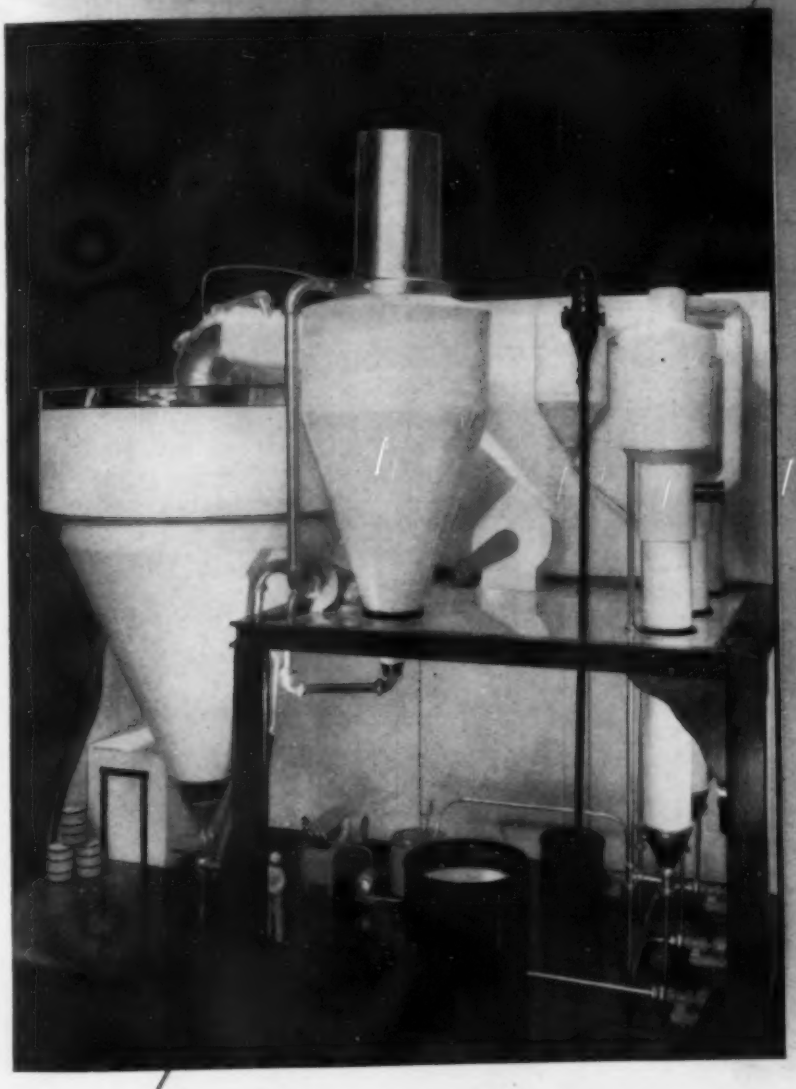
Minneapolis-Honeywell Regulator Co. has named O. B. Wilson industrial manager for the eastern sales region of the Brown Instrument division.

General Electric Co., Schenectady, N. Y., has made four appointments in the control division of the apparatus department. M. H. Blesh has been named manager of manufacturing; C. B. Bradish, manager of engineering; E. A. Green, manager of sales; and Thomas I. Hage, accountant.

Bee Chemical Co., Chicago, has elected M. A. Self vice president in charge of sales and a director of the company.

Swenson Puts Spray Drying to New Uses

Now spray drying is finding scores of new uses in the process industries. We must confess we are more than a little excited about it! So are the many chemical engineers who have discovered that Swenson Grav-Jensen Spray Dryers—



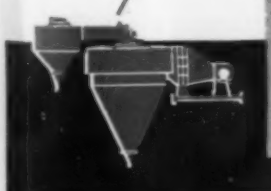
Display model of a typical Swenson Spray Dryer and Evaporator for chemical process application

1. Attain higher thermal efficiency
2. Recover solids completely, without loss
3. Control moisture content and product uniformity
4. Reduce labor costs
5. Protect heat-sensitive materials

The facilities of the Swenson Spray Dryer Research Laboratory are available for plant-scale tests. We will gladly send full information and schedule a test run of your material if it can benefit your process. The cost is nominal. Write giving full details.

These dissimilar products are spray dried successfully

- Alfalfa extract
- Animal blood
- Calcium carbonate
- Distillery slop
- Dyes and dyestuffs
- Magnesium carbonate
- Manganese sulfate
- Pentaerythritol
- Pharmaceuticals
- Pigments
- Polyvinyl Resins
- Starch (textile)
- Sulfite waste liquor and lignins
- Tannin liquors
- Zinc sulfate



SWENSON EVAPORATOR CO.
DIVISION OF WHITING CORPORATION
15669 Lathrop Ave. Harvey, Illinois
Export Department: 30 Church Street, New York 7, N. Y.

WORKS WHERE OTHERS WON'T

for
SUBMERGED
OILLESS
BEARINGS

SPECIFY
GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.
WITH CONFIDENCE

- OPERATE DRY or SUBMERGED IN DYES, PLATING, CLEANING & CHEMICAL SOLUTIONS, GASOLINE, FOODSTUFFS
- TRULY OILLESS AND SELF-LUBRICATING
- EXTREMELY DURABLE
- CONSTANT COEFFICIENT OF FRICTION
- APPLICABLE OVER A WIDE TEMPERATURE RANGE — even where oil solidifies or carbonizes
- EXTENSIVELY USED IN CONVEYORS, PUMPS & OVENS
- ROTATING SEALS OF GRAPHALLOY ARE UNEXCELLED

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CONVENTION PAPER ABSTRACTS

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Chemical Marketing Opportunities

CHEMICAL industry's recently developed and fast growing marketing activities offer fields of opportunity as great as those of its laboratories and factories.

We who have been in it for a while are very certain that there is, at the least, just as good an opportunity for the young chemist to utilize his training and ability and just as good an opportunity to get ahead in his chosen profession as there is in the field of pure or fundamental or synthesis research.

In fact, it sometimes seems that the challenge to his ability and ingenuity is greater. As a member of the team, he is just as important as the member who synthesizes the new product in the laboratory or the one who manufactures it in the plant.

There is no mistaking the fact that an organized staff for chemical marketing, or chemical development for those who prefer the latter term, is becoming a major part of the industrial

BOWEN LABORATORY SPRAY DRYER

...for developing new products and processes

● The Bowen Laboratory unit is designed to provide information which can be directly applied to the development of new products and processes. It is built under the same general designs as the large commercial Bowen engineered Spray Dryers. Factual information on request.

BOWEN ENGINEERING, INC.
Garwood 1, New Jersey

Nickel-lined steel 50% Caustic Evaporator under construction for Diamond Alkali Company

The $12,000,000 Diamond Alkali Job

BROWN & ROOT, Inc.

Chemical plants, such as the Houston Works of the Diamond Alkali Company, are a specialty of Brown & Root, Inc. We are engineering and erecting this vast and ultra-modern plant and will deliver it in production of caustic soda and chlorine. *Thanks to Industrial & Engineering Chemistry for this picture, which they used as a front cover illustration*

P. O. Box 2634
Houston, Texas

Hot Acid Filtration!

Woven Glass Filter Cloth is Outstandingly Successful!

NFM Glass Filter Cloth is woven from a special formula chemical glass which provides a maximum degree of chemical resistance. This woven glass filter cloth is completely resistant to acids (except hydrofluoric and hot phosphoric) in their most concentrated form. It will withstand extremely high operating temperatures—temperatures well beyond the limits usually encountered in the process industries.

Perhaps NFM Woven Glass Filter Cloth will solve some of your filtration problems. This cloth is available in twill, chain and plain weaves in numerous porosities and in widths from 26" to 72". It is also available as made-up filter element covers to fit all standard filters. Literature and pilot test samples available on request.

National Filter Media Co.
Sales Division of FILTER MEDIA CORPORATION
1717 DIXWELL AVENUE • NEW HAVEN 14, CONNECTICUT

SALES OFFICES

Felt Building
Salt Lake City 1, Utah

2627 West 19th Street
Chicago 8, Illinois

1008 Keith Building
Cincinnati 2, Ohio

team, collaborating with staffs engaged in the more fundamental aspects of research on the one side and production on the other.

Chemical marketing is a bridge between research and production, and lists among its many activities product evaluation and comparison, demand estimation, raw material and manufacturing facility studies, patent investigation, analysis of storage and shipment problems in terms of health and safety hazards, and investigation of complaints.

William H. Harding, American Cyanamid Co., before Chemical Marketing Section, American Chemical Society, Chicago, April 21, 1948.

Selling Colloids To the Public

SINCE the word "colloid" is all but meaningless, it should be discarded and replaced with a more intelligible name. If this is impracticable, in speaking and writing for the layman, the word "colloid" must always be explained; thus it might be made as familiar as "nuclear fission" has become.

Colloid chemistry must be sold to the layman by relating it to his daily life and habits, his health and his food; at the same time its relationship to organic chemistry and physics must be clearly explained.

Qualified colloid chemists should write books and articles, and present radio talks in a nontechnical but interesting manner. An educational program specifically for the layman might well be contemplated.

Some of the scientists objections to writing for the layman are discounted: his avoidance of generalizations, his desire for strict accuracy, and his dislike of overstatement and dramatization. Scientists should avoid a patronizing attitude and should regard the scientific literacy of the public as a challenge. Signs of progress in this respect are noted, but in colloid chemistry they are few. A splendid opportunity exists for following the path broken by atomic physics and taking advantage of the upsurge of public interest in science that it has created.

G. G. Hawley, Reinhold Publishing Corp., before Division of Colloid Chemistry, American Chemical Society, Chicago, April 21, 1948.

Colloid Chemistry for Chemical Engineers

COLLOIDAL problems are encountered not only in new processes and new lines of production, but throughout existing industrial installations on an almost universal scale. Changes made on the basis of colloid chemical reasoning, whether they be of a proc-

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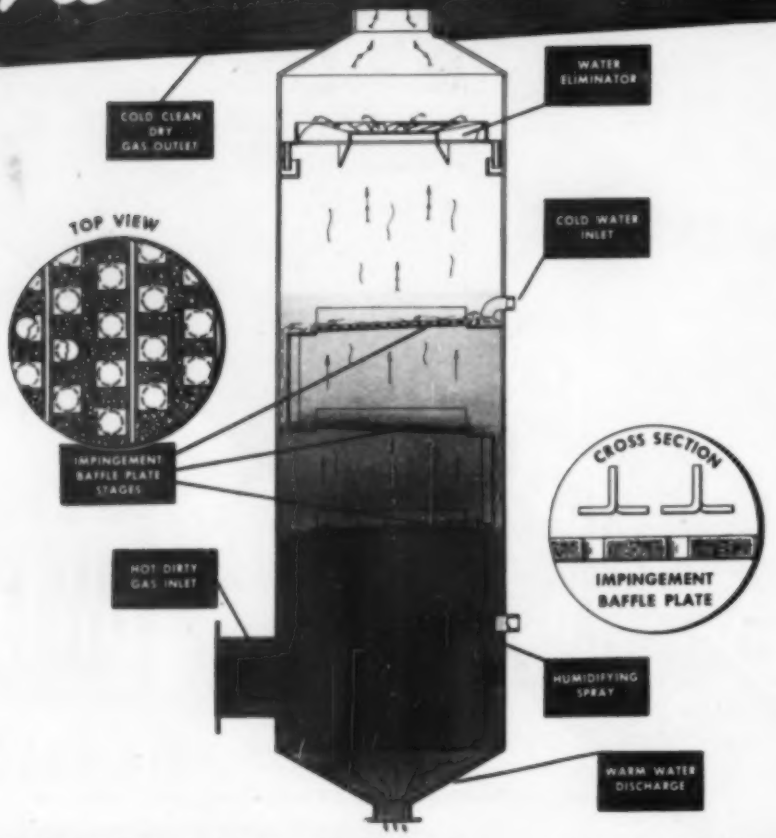

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are operating in many processing plants throughout industry. Peabody units **recover solid products, such as carbon from generators, soda ash from kilns, dextrose from packaging and mixing operations, etc.,** as well as **remove entrained solids from gases,** and **cool gases used in processing.** Available in sizes from 100 to over 100,000 cfm.

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Bulletin H-2021 gives further information on Peabody Scrubbers. Consult our Engineering Department for further details without obligation.

S-2

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essing nature or whether they affect the design of machines, can decrease the difficulties encountered in production and thereby improve it. Therefore, the teaching of colloid chemistry should advantageously be made compulsory not only for the chemistry and biology student but also for the chemical engineer.

Requirements and preparation for such work will be different to a certain extent from those necessary for the education of a research worker. The successful colloid chemist or colloid chemical engineer will of course need a thorough basic and theoretic training in colloid chemistry with physicochemistry as a pre-requisite. However, special emphasis should be given to enlarging the observation power of the students, possibly through the use of class demonstrations and quizzes based on the successful explanation of experiments. The application of the various colloid chemical phenomena should be discussed in detailed relation to industrial problems. This might be done in the form of a seminar where each student is permitted to discuss one particular kind of problem of his choice and connected with some industrial process or production.

D. S. le Beau, Midwest Rubber Reclaiming Co., before Division of Colloid Chemistry, American Chemical Society, Chicago, April 21, 1948.

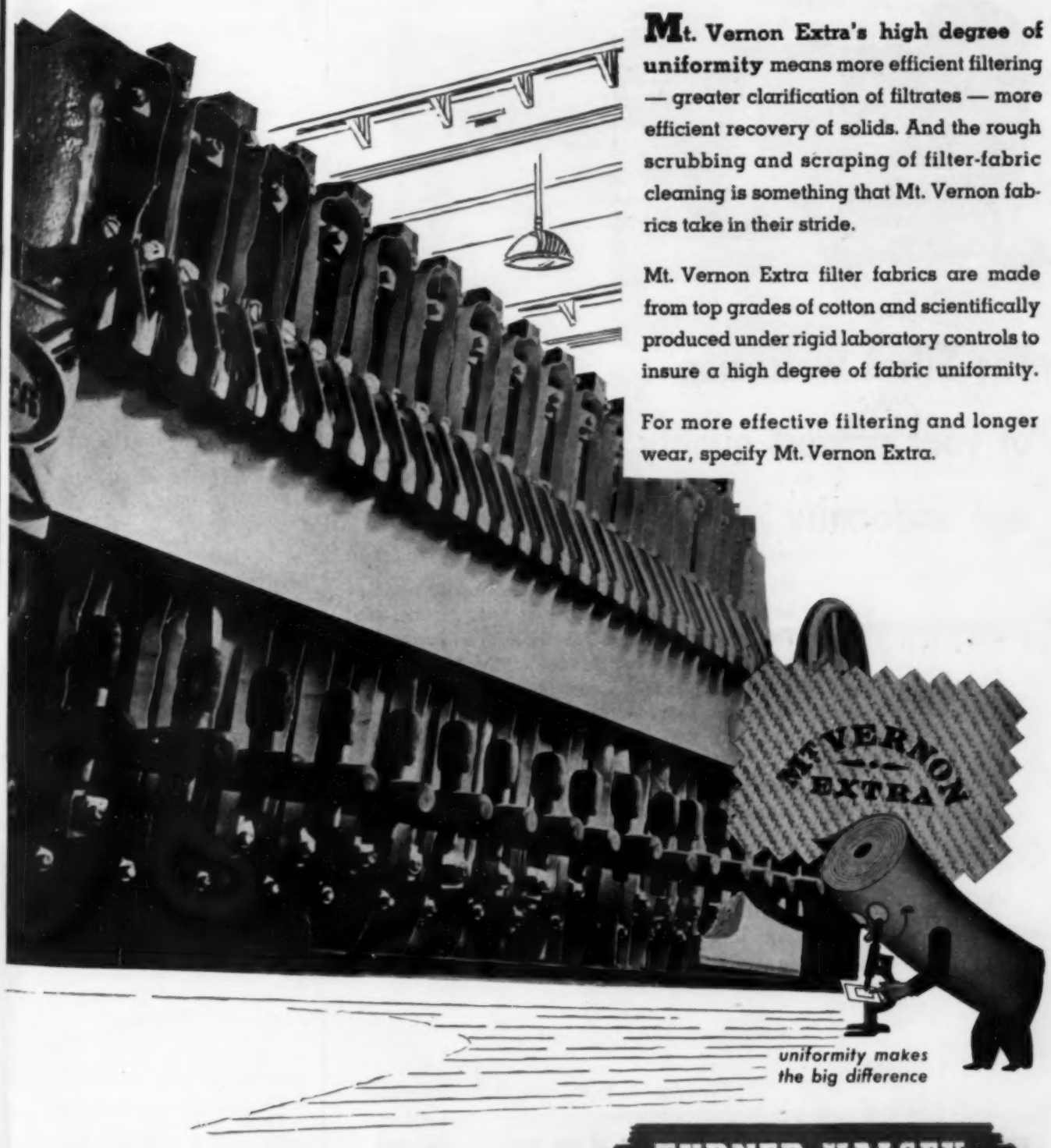
Philosophy of New Product Development

INDUSTRIAL research falls into various categories, including process development and product development. Each has as a common objective, the production of a useful chemical. No product has a value unless it has a use. Utility therefore becomes the primary consideration in new product development.

Utility consists of functional properties, cost, availability, stability, toxicity, and other characteristics which are the primary concern of the application laboratory and technical service. These properties can be measured only in terms of customer's requirements, actual or potential, and in comparison with established competitive products. If the importance of utility is recognized and the responsibility for evaluating functional properties assigned clearly to technical service, the approach to new products can be made systematic. Research, process development, chemical engineering, technical service, and sales all contribute and cooperate. Too often time and effort are wasted by lack of adequate evaluation or poor definition of the problem.

The opportunities for new product

For More Efficient Filtering ...Mt. Vernon Extra



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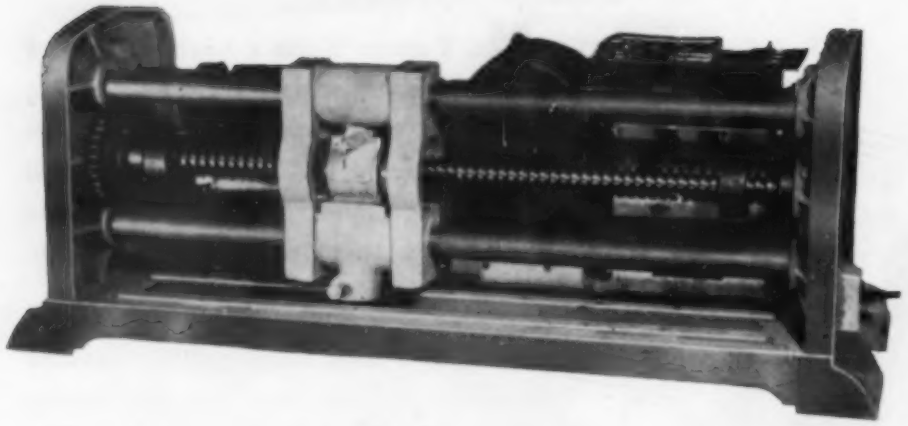

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development increase as the chemical industry and the chemical processing industries expand. Each new product serves as a stepping stone to new derivatives and new applications. Greater and greater complexity accompanies expansion, and specialization becomes more and more essential. Technical service must equip itself with expert knowledge to render the help necessary in the development of new products and new markets.

K. H. Klipstein, Calco Chemical Division, American Cyanamid Co., before Division of Industrial and Engineering Chemistry, American Chemical Society, Chicago, April 21, 1948.

Silica-Magnesia in Fluid Catalyst Cracking

DEVELOPMENT and pilot plant testing of synthetic silica-magnesia catalyst for use in fluid catalyst cracking has been carried out in various pilot plants including the 100 bbl.-per-day fluid catalyst cracking unit. The over-all results show that this catalyst is superior to synthetic silica-alumina and treated natural clay catalysts with respect to gasoline yield. The gasoline octane numbers are, however, lower than those obtained with silica-alumina, but approach those obtained with natural catalyst. The silica-magnesia catalyst is indicated to be superior from the standpoint of activity maintenance. The silica-magnesia catalyst is now in commercial production and demonstration tests in full-scale commercial cracking units will probably be made early in 1948.

R. W. Richardson, F. B. Johnson and L. V. Robbins, Jr., before Division of Petroleum Chemistry, American Chemical Society, Chicago, April 19, 1948.

Molecular Weight of C_2ClF_3 Polymers

THE MOLECULAR weight of a randomly selected lot of chlorotrifluoroethylene polymer was determined by the ebulliometric method with both benzene and carbon tetrachloride as solvents. The modified Menzies-Wright molecular weight apparatus was used for the molecular weight measurements in solutions up to 13 weight percent of the polymer and the modified Cottrell apparatus was used for the molecular weight determinations in the more concentrated solutions.

These molecular weight values, when plotted vs. the weight percent of the polymer in solution, give a curve somewhat S-shaped which can be divided into three distinct sections.

The part of the curve averaging the data for the molecular weight values in concentrations less than 10 weight

Oil Company

"Without doubt, YARWAY Steam Traps are finest traps ever built. All trap replacements will be YARWAY hereafter."—Oil Company, Texas.

Cleaning Plant

"As soon as we installed the YARWAY trap our trouble ended. Since then, when other traps gave trouble, we put in YARWAYS and they always did a much better job. Now we use all YARWAY traps," says Maintenance Engineer of large mid-western cleaning firm.

Dairy Company

"YARWAY Traps have been a life-saver here. Used many different makes before trying YARWAY a year ago. Haven't touched them since. Trying to get management to buy more."—Large Wisconsin dairy.

Dye Works

Use a good many YARWAY Traps here—like them very much on dryers. Take up little room and discharge condensate as fast as it comes through the line, causing coils to heat up faster and hold steady temperature."—Globe Dye Works, Philadelphia, Pa.

SPEAKING OF STEAM TRAPS

Laundry

"Ironer is so hot it sizzles after putting YARWAY trap on in place of a bucket trap. Run heavy spreads through ironer once and they are dry. Pulling out all bucket traps and will replace with YARWAYS."—Farina Laundry Co., Vancouver, British Columbia.

Power Station

"A great many YARWAY Traps are used here and have been very successful... some of these traps have been in use since 1939 and have given absolutely no trouble."—Herkimer Municipal Power Station, Herkimer, N. Y.

Florist

"Coal bill last winter was $5,000 less than previous winter. Didn't know whether they could give YARWAY Traps all the credit, but they were entitled to a big share of it."—Meyers and Santman (Greenhouses), Wyndmoor, Pa.

Hospital

"Ten years ago replaced an.....trap with a tiny ½" #60 YARWAY on an ironer. Never had such good results before. Trap has never been opened and still going 100%. Since then have bought nothing but YARWAY Traps and will specify them for new addition."—Northern Wisconsin hospital.

ACTUAL SIZE
½" TRAP

Textile Plant

"One large press formerly equipped with a bucket trap wouldn't heat lower platen. A ¾" YARWAY Trap was installed and since then full production has been maintained. This represents an increase of 20% in production."—Southern textile mill.

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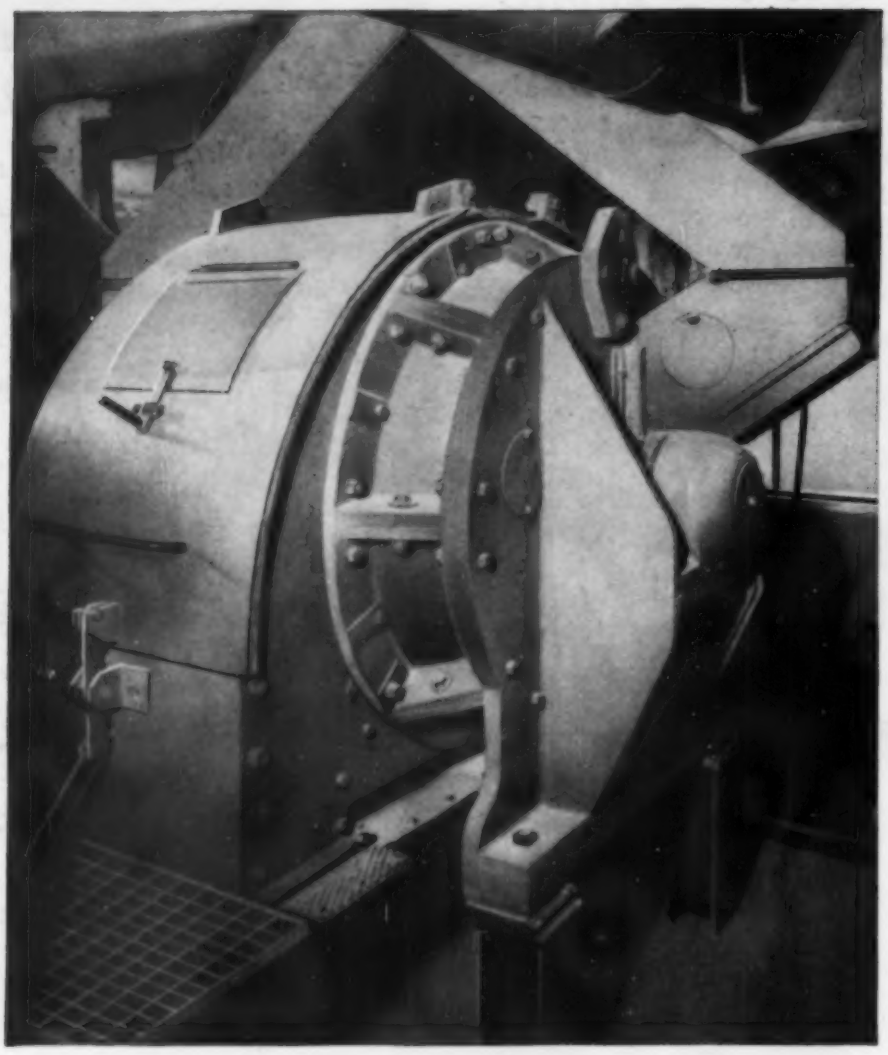

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PRATER PULVERIZERS

percent is exponential. The equation representing this part of the curve is $M = A^w + 845$, where M is the molecular weight of the polymer, w is weight percent of the polymer, and A is a constant, equal to 1.447.

The curve for concentrations of the polymer above 10 weight percent shows the molecular weight to increase directly with increased weight percent to an approximate concentration of 55 weight percent. The equation for the molecular weights along this section of the curve is $M = 10w + 783$.

At approximately 55 weight percent of the polymer the curve averaging the molecular weight data is slightly curved and the data from 55 to 65.8 weight percent, the maximum concentration investigated, falls reasonably well along a second straight line. The equation for the molecular weights along this section of the curve is $M = 4.545\ w + 1,089$.

The assumed correct molecular weight of the randomly selected lot of the polymer is the extrapolated value determined at zero concentration of the polymer in benzene and is 846 ± 5 molecular weight units.

The variation of the molecular weight of the polymer in benzene solutions as a function of concentration is attributed to differences in internal pressures and polarities of solute and solvent.

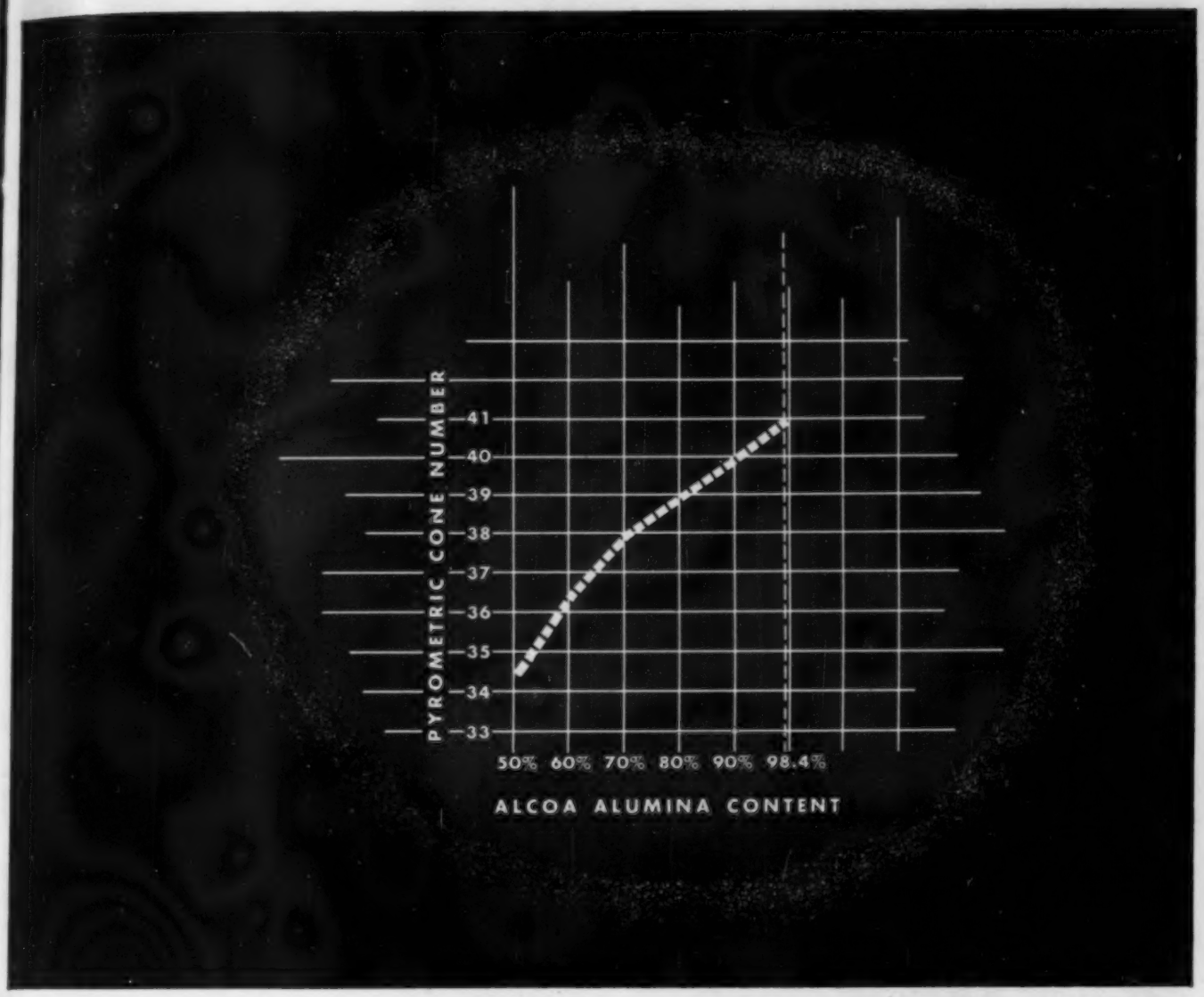
James L. Gabbard et al, Carbide and Chemicals Corp., before Division of Colloid Chemistry, American Chemical Society, Chicago, April 19, 1948.

Of Historical Interest

FURFURAL was offered as a new and interesting chemical in the 1920's to a chemical world, industrial and academic, which had come out of World War I with an enthusiastic interest in chemistry, awakening to the big possibilities, especially in organic chemistry, and with greater confidence in the ability of American chemists and American chemical industry as a result of this country's achievements after having been thrown on its own resources in 1914 when German exports ceased.

Prior to that time it was taken for granted that one had to go to Germany not only for the best chemical training, but to obtain almost all chemicals, especially those of good quality.

An example was the use by a certain American manufacturer of a formula for which he imported certain chemicals, among them two listed in the German catalogue as "Brown Z-1" and "White Z-2." Eventually he discovered that the first was ferric chloride and the second sodium carbonate. This is perhaps an extreme example of a situation which World War I



Data, Courtesy of Harbison-Walker Refractories Company, Pittsburgh, Pa.

Refractory Stability Goes UP with the Alcoa Alumina Content!

The chart shows how ALCOA Alumina pushes up the pyrometric cone equivalent of refractories. But this is just one important factor in maintaining peak operating efficiency. The reason why refractories made with ALCOA Alumina last longer and result in less costly downtime is because ALCOA Alumina gives refractories the following money-saving qualities:

- **Strength and stability under load at high temperatures.**
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BUY FROM YOUR REFRACTORY MANUFACTURER—You can buy brick and other shapes containing various percentages of ALCOA Alumina to meet your operating temperature requirements from leading manufacturers. We do not make refractories, but we'll gladly refer you to dependable sources of supply. Call your nearest Alcoa sales office or write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1778 Gulf Building, Pittsburgh 19, Pa.

ALCOA

ALCOA CHEMICALS

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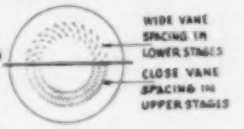

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LIQUID-VAPOR INTIMATE CONTACT EQUIPMENT for DUST COLLECTION ABSORPTION CONDENSATION AND TEMPERATURE REDUCTION

fortunately forced us to correct and as a result our domestic chemical industry received a tremendous impetus. New chemicals received much more attention during the 20's than they would have before the war.

By the time the 1930's arrived, new chemicals were being announced in such numbers that the industry began to be surfeited and from that time on, it has become increasingly necessary to back up the announcement of a new chemical with chemical and physical data plus definite information on how it may be used. This is a healthy situation and puts the burden of proof at least initially where it belongs, on the manufacturer.

Lauren B. Hitchcock, Quaker Oats Co., before Chemical Market Research Association, Cambridge, Mass., April 8, 1948.

Hypersorption Report

THE FIRST commercial Hypersorption plant was build for Dow Chemical Co. at Midland, Mich., to recover small concentrations of ethylene from a hydrogen-methane stream at 75 psig. The unit, designed by Union Oil Co. of California and Foster Wheeler Corp., was completed in May 1947 and its performance during start-up and operation since that date has been successful beyond design expectations. From a feed gas containing 4.5 to 6.0 volume percent ethylene, an ethylene product is obtained of 92 to 93 percent purity and 0.1 percent maximum methane contamination. The hydrogen-methane overhead stream contains less than 0.1 percent ethylene. This product yield and purity have been maintained consistently over the entire period of operation despite considerable fluctuation of feed volume and composition inherent in the gas supply. During its history of operation the unit has proved its ability to absorb increases in ethylene content of the feed as high as 400 percent of the design composition for several hours before appreciable quantities of ethylene are lost overhead in the discharge gas. All during this "flood" condition the purity of the ethylene product remained unchanged.

The process consists of the introduction of the feed gas into a slowly moving bed of activated carbon which is designed to adsorb the heavier components of the mixture. The carbon containing the adsorbed components is then contacted in the rectifying section below the feed engaging tray with a countercurrent reflux of the bottoms product, which serves to displace any of the lighter overhead components originally adsorbed from the feed.

Now saturated with the bottoms product, the carbon next passes

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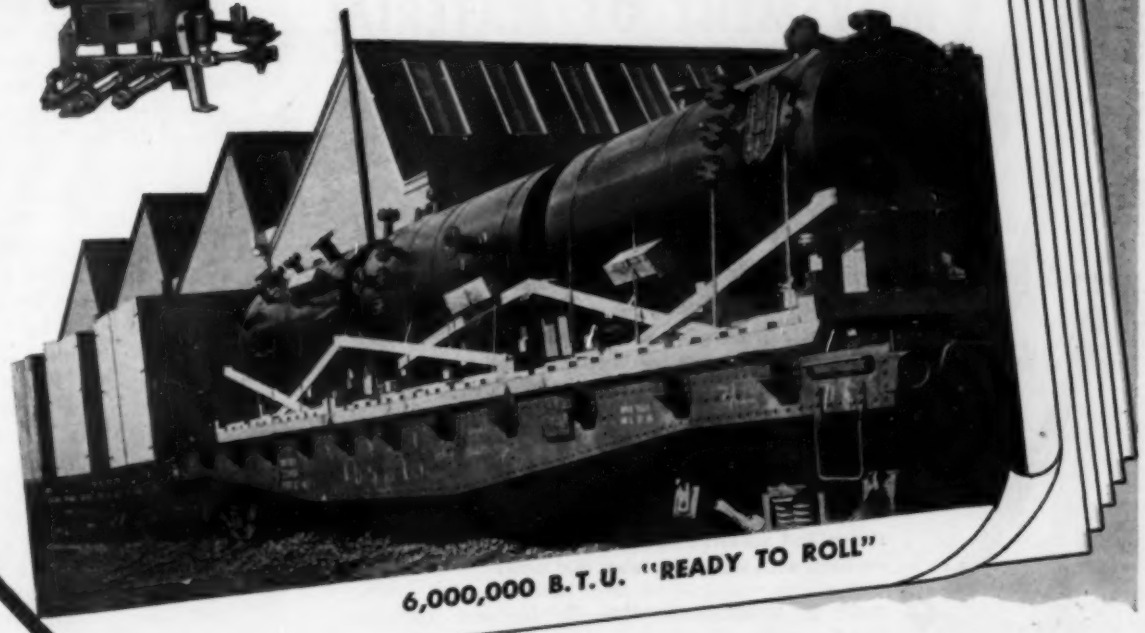
The total capacity is 6,000,000 B.T.U. — but units can be operated singly (2,000,000 B.T.U.), in pairs (4,000,000 B.T.U.) or all three (6,000,000 B.T.U.). Two units can carry the load temporarily, while one is being inspected or serviced. Small floor space required even for three units.



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HUNDREDS of McKee Dowtherm Vaporizers are being used because of their dependable, long-term ability to develop high temperature at low pressure — and *low cost* — preventing local overheating, discoloration, burning or scorching.

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2 **GLAND UNDER SUCTION PRESSURE ONLY**—Since it is not subject to high stuffing box pressures, it is much less vulnerable to abrasive solids. Packing troubles are reduced to an absolute minimum . . . and there is considerably less dilution of your mixtures due to leakage.

3 **CORROSION-ABRASION RESISTANT**—The Morris Type R has no internal studs and bolts . . . no troublesome internal fits and joints. For ore processing, the alloy parts of the Type R stand up under the severe wear of corrosive and abrasive materials. These parts are easily renewed with minimum labor and time.

4 **SHELL IS INTERCHANGEABLE**—Suction and discharge nozzles can be swiveled around the axis of the pump to any of 72 different locations. Changed for either right or left hand rotation.

MORRIS TYPE "R" SLURRY PUMPS

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IN CHEMICAL PROCESSING it handles mixtures containing ore concentrates . . . tailings, slag and residue from filters and classifiers . . . all types of caustic or acid mixtures containing abrasives or solids.

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MORRIS Centrifugal Pumps

through the stripping section, a vertical tube bundle heated externally by condensing Dowtherm vapors. Complete stripping of the adsorbed components is accomplished by steam, which is introduced into the bed below the heating section and passes up through the tube bundle countercurrent to the carbon. The steam and desorbed bottoms product or "make gas" are disengaged from the bed at a tray above the stripping section and just below the rectifying section.

The hot stripped carbon leaving the Dowtherm heater passes through a specially designed feed mechanism which provides positive control of the carbon flow rate and distribution over the cross section of the column. From this mechanism the carbon drops into a sealing leg which restricts flow of steam into the lift system. A gas lift transports the carbon to the top of the Hypersorber tower where the flow is reversed by an impactless separator of special design which reduces attrition to a minimum. The volume of gas recycled from the top of the tower to the lift-gas blower is designed to obtain sufficient elutriation of carbon fines to maintain the desired mesh size in the adsorption beds.

The lighter components of the feed, which are not adsorbed or are displaced from the carbon by the bottoms product reflux, pass up through the adsorption section and are split into two streams. The major stream is disengaged below the cooler and constitutes the overhead product or "discharge gas." A small part of the overhead gas serves to dehydrate the stripped carbon by passing up through the tubes of the cooler countercurrent to the carbon flow. This "purge gas" then joins the lift-gas circulation stream, an equivalent amount of which is taken off before the blower suction, to remove the carbon dust formed by attrition during operation and entrained in this stream by elutriation at the top of the Hypersorber.

Howard Kehde, R. G. Fairfield, J. C. Frank and L. W. Zahnstecher, before American Institute of Chemical Engineers, Cleveland, May 9-12, 1948.

Incendiary Gels

Liquid incendiaries tested during World War I possessed the drawback of excessive dispersion, which was, however, moderately well correctable by the absorption of the liquids in some materials such as cotton waste.

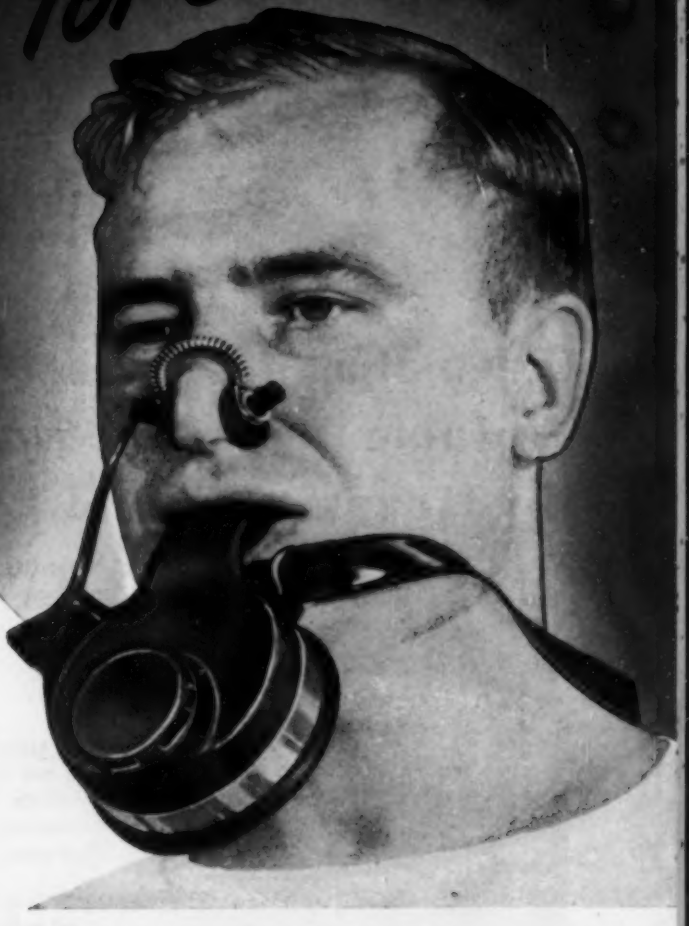
During World War II, this general idea was revived resulting ultimately in the incendiary gels. Of all the various methods tried for solidifying incendiary fuels, the use of the following substances were found to be generally applicable: (1) sodium stearate, (2) aluminum salts of mixed fatty

CARRIED IN THE POCKET

OR WORN AROUND THE NECK—

Ever ready for Service

THE *New* M·S·A *Gasfoe* CARTRIDGE RESPIRATOR



- Dependable protection
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- Chemical cartridge of long service life easily replaceable

Fast, easy, dependable respiratory protection whenever light concentrations of acid gases or organic vapors temporarily threaten breathing safety! The M.S.A. Gasfoe Cartridge Respirator answers the demands of industry for a small, handy, compact unit which is instantly available for use when needed.

Featuring a specially-designed mouthpiece, which is an integral part of the rubber respirator body, the Gasfoe employs a single, replaceable, factory-packed chemical cartridge which absorbs light concentrations of acid gases and organic vapors from inbreathed air. Equipped with a spiral spring noseclip and adjustable vinyl plastic neckband, the respirator is comfortable to wear, well-balanced, simple to maintain, and provides long life in service.

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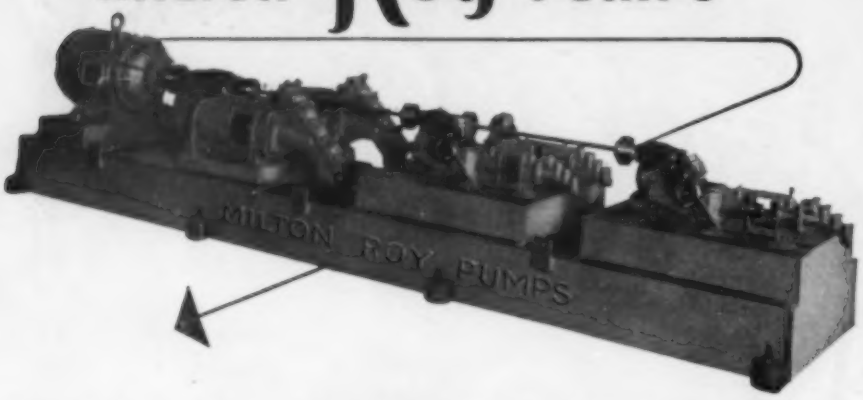
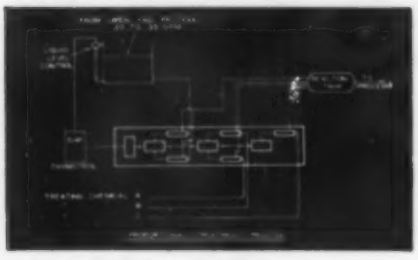
MILTON Roy PUMPS



Regulating the Speed of Controlled Volume Pumps *Automatically* by Means of Liquid Level Control

In this typical processing application the product, received from an open end process at 20 to 35 gals. per min. is treated with three chemicals, added at rates exactly proportional to the rate at which the material is received. It is then pumped under pressure to a reaction vessel.



A 5-cylinder Milton Roy Controlled Volume Pump is used in this system. The 2 large cylinders handle the liquid from a surge tank fitted with liquid level control. The 3 small cylinders add the three treating chemicals. The speed of the drive of this combined pumping unit is automatically regulated through Thymotrol by the liquid level in the surge tank. If the level rises or falls the entire unit speeds up or slows down instantly in exact proportion to the speed of the first 2 cylinders. It is possible by manual stroke adjustment to change the ratio of each of the three treating chemicals while the system is in operation.

Milton Roy Controlled Volume Pumps are finding many such applications, in many fields, for a wide range of chemical treating purposes. Milton Roy engineers are competent to help develop similar systems and build pumps to meet specific requirements. Consultation is invited.

Write for the latest Milton Roy Pump Catalog No. 146

MILTON Roy COMPANY

1322 E. MERMAID AVE., CHESTNUT HILL, PHILA. 18, PA.

acids and naphthenic acid, (3) polyacrylates, and (4) rubber (natural and synthetic).

Sodium stearate would not give a satisfactory product with incendiary fuels; stearic acid, however, when dissolved in the incendiary liquid produced excellent gels after the addition of sodium hydroxide dissolved in 85 percent (or purer) alcohol. SOD 112, a product of the Standard Oil Co. of New Jersey, was the most promising of this type of gel.

Aluminum soap thickeners consist of either an aluminum salt of the soap-forming, saturated, fatty acids having 8 to 14 carbon atoms, an unsaturated soap-forming, fatty acid, a carboxylic acid containing a carbocyclic ring—e.g., naphthenic acid—or a mixture of these. Napalm, the aluminum soap of an oleic, naphthenic, and coconut fatty acid mixture, falls into this class of thickeners and a review of this substance, from the standpoints of chemistry, manufacture, stability, effect of moisture, gasoline quality, etc., is presented.

In lieu of soaps, natural and synthetic rubber as well as resins such as the polyacrylates can be used as thickeners, yielding, however, gel products possessing properties somewhat different in their characteristics from those of the soap-thickened fuels.

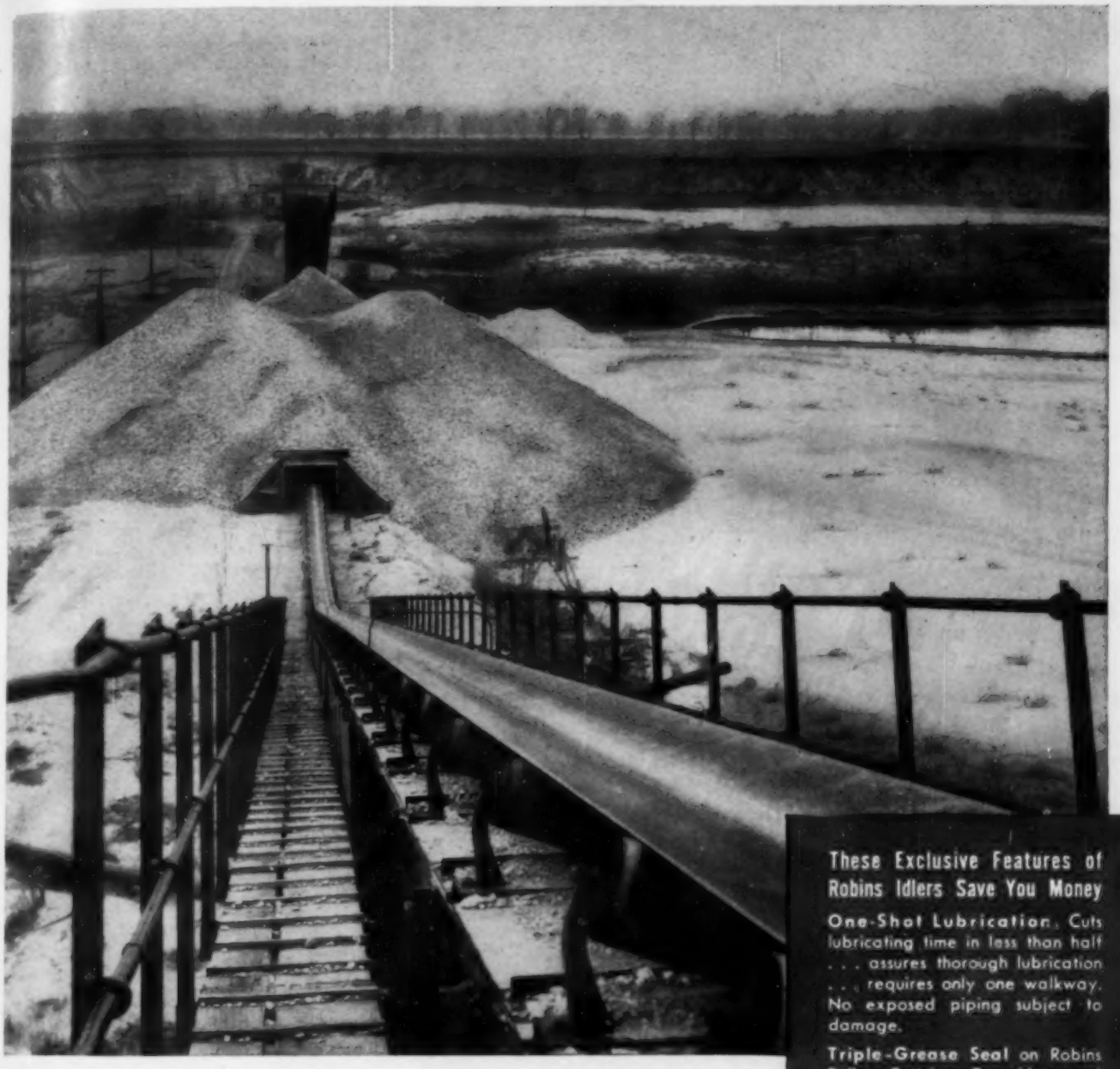
Walter H. C. Rueggeberg, Chemical Corps Technical Command, before Division of Colloid Chemistry, American Chemical Society, Chicago, April 20, 1948.

Sawdust Neutral Spirits

PLENTIFUL supplies of good whiskey could be made cheaply from sawdust and oil refinery wastes, saving huge quantities of grain for food. Alcohol identical in quality with that obtained from grain can be made by the utilization of non-edible raw materials, if the Treasury will allow their use. For example, the process for the production of good ethyl alcohol from sawdust has been thoroughly perfected and tested. And in fact, there is a plant already built at the cost of over $3,000,000 which could be easily started and could supply us with 10,000,000 gal. of alcohol per year—enough to make over 25,000,000 gal. of whiskey.

About two and one-half gallons of alcohol are made from a bushel of corn or wheat, now urgently needed for food, and more than 10,000,000 tons of sawdust are wasted annually, each ton capable of yielding about 50 gal. of alcohol. This source alone is enough to supply more than three times the conceivable demand for alcoholic beverages.

Alcohol as good as the grain product can also be made from natural gas and petroleum refinery wastes. All these sources are cheaper than grain at



Speed production...lower costs!

Insist upon time-proved Robins Belt Conveyors... no matter what type of material you move

When you move bulk materials with a Robins Belt Conveyor, you can be sure that both belt and conveyor are engineered to work together.

Only Hewitt-Robins provides a *single responsibility* for both elements—machinery and belt.

But that's not all! Exclusive One-Shot Lubrication of Robins Idlers permits your conveyor to be built with only *one walkway!* You save construction and maintenance costs... you save hours of lubricating time.

Furthermore . . . with a Robins Conveyor you get the advantage of minimum clearance between pulleys. This reduces possibility of pinching belt between horizontal center pulley and inclined end pulleys. Malleable iron brackets on troughing and return idlers give your conveyor added strength—resist fatigue, breakage.

With dependable Hewitt Belting and a Robins Belt Conveyor you are sure of a system that speeds production . . . lowers costs. No matter what bulk materials you move, write Robins for details. Address Robins Conveyors Division, 270 Passaic Avenue, Passaic, New Jersey.

These Exclusive Features of Robins Idlers Save You Money

One-Shot Lubrication. Cuts lubricating time in less than half . . . assures thorough lubrication . . . requires only one walkway. No exposed piping subject to damage.

Triple-Grease Seal on Robins Roller Bearing Troughing and Return Idlers. Locks grease in, keeps dirt and moisture out.

Rigid-Truss Construction. End and center brackets, pulleys and pulley shafts form a single unified member to absorb shocks and loads. Stronger than any other type of construction.

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CONVEYORS

ROBINS CONVEYORS DIVISION HEWITT-ROBINS INCORPORATED

HIGH on the list of adsorbents, where they have been for 35 years, you will find Floridin products. In the making of aviation gasoline, lubricating oils, synthetic rubber, and many chemicals, the most advanced and the most exacting processes are giving new proof of the effectiveness of these adsorbent products. A staff of technicians is employed to give aid and advice as users may require. If you have a problem of adsorption—dehydration—decolorization—catalysis, your inquiry will be given careful, competent attention.

Floridin
ADSORBENTS
FLORIDIN COMPANY
Department A . . 220 Liberty St. . . Warren, Pa.

present prices. That alcohol could be produced from sawdust and wood waste for one-third of its cost from grain.

The customer might not be able to tell the difference between the whiskey suggested and that now on the market, and that even if labeling were required the public eventually might become accustomed to slogans such as "Made From Wood, Aged in Wood." Passing the alcohol through wood shavings would speed the aging process considerably.

All these processes have been thoroughly tested and could come in handy in the critical year of 1948. The drawbacks are only due to government regulation or possible lack of public acceptance.

Robert S. Aries, Polytechnic Institute of Brooklyn, before Division of Sugar Chemistry and Technology, American Chemical Society, Chicago, April 23, 1948.

Good News for Teachers

TEACHERS' salaries should be based on evaluation of position according to duties, responsibilities and prerequisites, rather than merely by title, and commensurate with earnings in other fields where requirements are similar.

The ASCE Board of Direction has adopted a formula which applies slide-rule precision to the grading of teachers, and is providing deans of civil engineering schools with rating sheets and other data evolved during our study. A year-long study was made by the society's committee on salaries during a period when the problem of teachers' salaries was a subject of national interest, particularly for educators.

Under the formula a maximum of 150 points is assigned to educational background; 150 to previous experience; 400 to responsibilities of the teacher, divided as follows: supervision, 100; policy of methods, 120; public relations, 80; records and reports, 40, and machinery, safety, etc., 60.

Our study indicates clearly that the position of full professor and that of division engineer demand equivalent prerequisite duties and responsibilities. At this stage in teaching and at this stage in practice, the experience already obtained and the technical development already reached are such that the incumbent can thereafter qualify for the highest position in teaching or in practice if he has the opportunity. The practitioner will rate higher in some, and the teacher higher in others, but the scores on duties, responsibilities, and prerequisites, translated into point values, will be substantially the same.

Salaries recommended are: instructors, from $2,700 to $4,200; assistant

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Satincast, smooth as satin itself . . . is a newly developed finish by COOPER ALLOY which is *Standard* on all COOPER Stainless Steel Fittings. *Satincast* finish is also available on Special Castings of moderate size.

* T.M. REG. PENDING

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This famous COOPER ALLOY electrolytic polish for fittings and castings brings out the natural brilliant luster of Stainless Steel as well as greatly increasing its resistance to contamination and corrosion. Lustracast finish is available at a slight extra cost.

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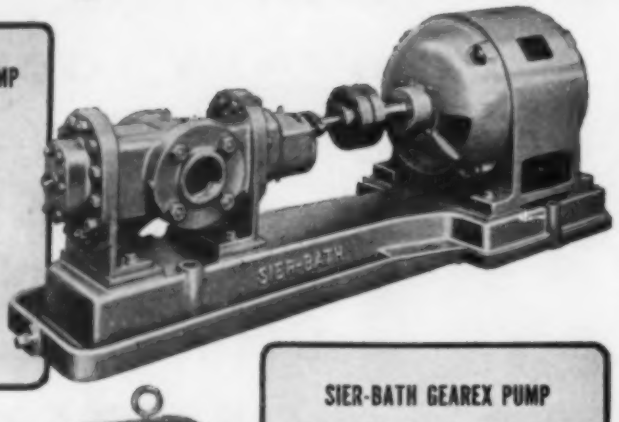
HILLSIDE, NEW JERSEY

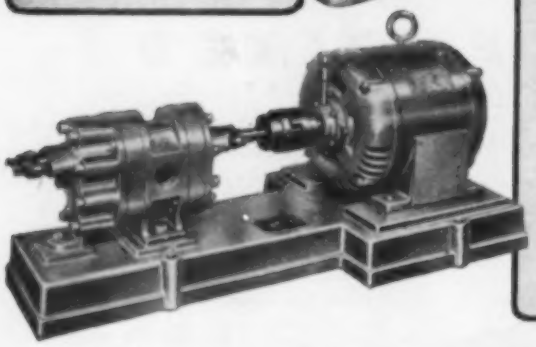
ONE PUMP working on the job is *worth a dozen* in the repair shop!

SIER-BATH SCREW PUMP

Advantages: • pulseless flow • anti-friction bearings • vibrationless operation • low maintenance cost • rugged construction.

Pumps: Acetate, asphalts, brines, Bunker C Fuel Oil, Cellulosics, Greases, Molasses, Syrups, Lube Oils, etc.





SIER-BATH GEAREX PUMP

• Balanced Axial Thrust • Pulseless Flow • Vibrationless Operation • Roller Bushings for Precision Running under load.

Pumps: Oils, Varnishes, Solvents, Molasses, Chemical Solutions.

Capacities: 1-550 g. p. m.

Discharge: 250 p. s. i. for medium or high viscosities. 50 p. s. i. for water.

The most notable point about SIER-BATH Screw Pumps and Gearex Pumps is their relative freedom from maintenance.

THERE is no mystery about the ability of Sier-Bath Pumps to stand up under the most trying conditions. After all, in such pumps, the worms and gears are the most important parts. And when you consider that Sier-Bath Pumps are made in the best equipped precision gear shop in the country, it is easy to understand their exceptional dependability. Their pulseless flow and vibrationless operation greatly reduce maintenance cost—there is much less wear on valves, couplings and other fittings. Pipes and joints remain tight. With labor costs at their present high figures, these are important points to consider in pump selection. Send for descriptive booklet.

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professors, $4,200 to $6,100; associate professors, $6,100 to $8,600 and professors, $8,600 to $12,000. Median salaries in these categories reported by deans of 71 of 104 schools to which rating sheets were sent in our study were, respectively, $2,500, $3,300, $4,000 and $4,600, as against the recommended medians of $3,400, $5,100, $7,250 and $10,350.

Teaching salaries should approximate the prevailing rates for practitioners in permanent employment, otherwise we cannot hope to hold the large number of teachers who can and will abandon teaching because they cannot live on the salaries paid, or to attract the high grade educators who could be equally successful in either field.

Ralph B. Wiley, Purdue University, before American Society of Civil Engineers, Pittsburgh, April 5, 1948.

New Bisulphide Process

A PROCESS has been developed for making carbon bisulphide from sulphur dioxide and anthracite coal. Sulphur dioxide to cardon bisulphide conversions ranging from 75 to 90 percent were obtained in an apparatus producing up to 0.5 lb. per hr. of carbon bisulphide.

It was shown that the over-all process can be represented by the following equation: $5C + 2SO_2 \rightarrow CS_2 + 4CO$, and that the process actually took place in three steps. High carbon bisulphide yields could be obtained only when these steps were carried out individually at the optimum temperature for each step. The heat value of the byproduct carbon monoxide was several times that necessary to carry out the process, indicating an autogenous process, should the carbon monoxide be used as a fuel to heat the reaction chamber.

C. W. Siller, New Jersey Zinc Co. (of Pa.), before Division of Industrial and Engineering Chemistry, American Chemical Society, Chicago, April 21, 1948.

Importance of Near-Eastern Petroleum

SECURING oil from the Middle East has become one of the vital concerns—not only of the oil industry—but of the United States itself. The western hemisphere at present has a surplus of oil production. But estimates of future production and needs, barring some unexpectedly huge new discoveries in this hemisphere, show that this surplus probably will disappear about 1951-52. By 1955 the hemisphere would be needing to receive half a million barrels a day from the eastern hemisphere (mostly the Middle East).

As far as the United States is concerned, by 1951 it will most likely be

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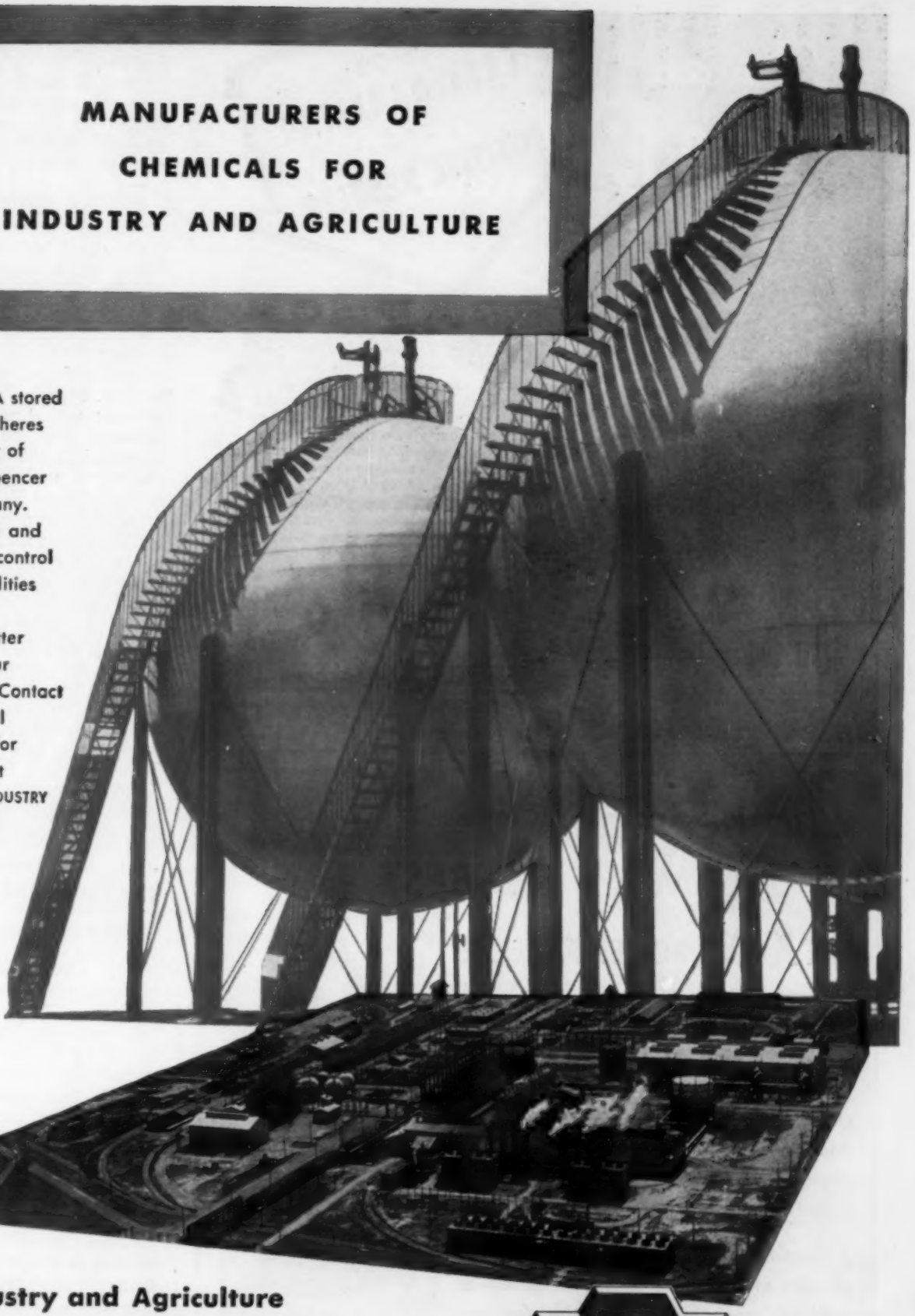

TONS OF AMMONIA stored in giant hortenspheres insures continuity of production by Spencer Chemical Company. Modern facilities and skillful technical control of Spencer's facilities means constant production of better chemicals for your industrial needs. Contact Spencer Chemical Company today for information about CHEMICALS FOR INDUSTRY AND AGRICULTURE.

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COMPACT, PORTABLE

This Alsop "*Sealed-Disc*" Filter positively removes all impurities. Its unique design assures unsurpassed performance on intermittent or continuous operation and with little or no supervision. You'll find this compact filter always ready for instant use, completely sealed, leak and drip proof and easy to move to wherever needed.

Alsop filters of various sizes, made of suitable materials, are at work on chemicals, plating solutions, liquid plastics, liquid soaps, drugs, syrups, foods, beverages, oils, fats, alcohol, water etc. Write for complete details.

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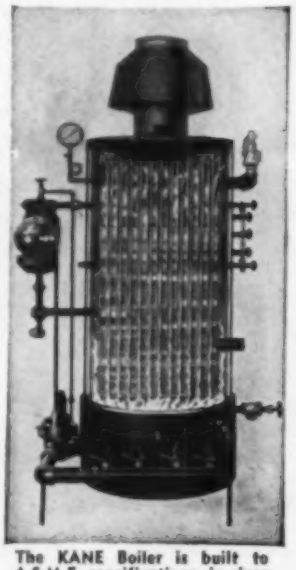
Yes, it's a compact, self-contained steam source that includes: the correctly sized KANE Automatic Gas-Fired Boiler complete with burner and controls to maintain required steam pressure; *and* an M-K-O Automatic Boiler Feed system designed to return condensate and supply make-up water as required for highest operating efficiency.

Engineered Steam at its best with four decades of experience at your disposal—so, send *your* steam problem to us for study and recommendation.



The KANE Boiler is built to A.S.M.E. specifications, in sizes to 30 H.P.

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1903-1915 EAST HAGERT STREET, PHILADELPHIA 25, PA.
FOUR DECADES OF AUTOMATIC GAS-FIRED BOILER MANUFACTURING EXPERIENCE

having to receive over half a million barrels a day net imports from the outside; and by 1955 it will probably need upwards of a million barrels daily.

Around one half, or perhaps less, of this we can expect from South America—the rest in all probability will have to come from the Middle East.

Because of staggering costs involved, there is little probability that synthetic plants, producing oil from gas, coal or shale, could make any substantial contribution to this million barrels a day shortage by 1955.

Processes for the manufacture of gasoline from natural gas are now being developed, though no plants have yet been built. But there is yet no evidence that gasoline can be manufactured from coal or shale on a commercial basis. The plants alone to produce a million barrels daily of synthetic liquid fuels from coal probably would cost upwards of $8 or $10 billion or even more.

On the other hand, Middle East crude can be produced and brought to this country through modern pipelines and large, fast tankers at an economical cost. Such pipelines and tankers, and the conventional refining capacity required to bring to this country and to process a million barrels daily of Middle East oil would involve a capital outlay in the neighborhood of $2½ billion, and no new technical problems would be involved.

S. A. Swensrud, Gulf Oil Corp., before Cleveland Petroleum Club, March 29, 1948.

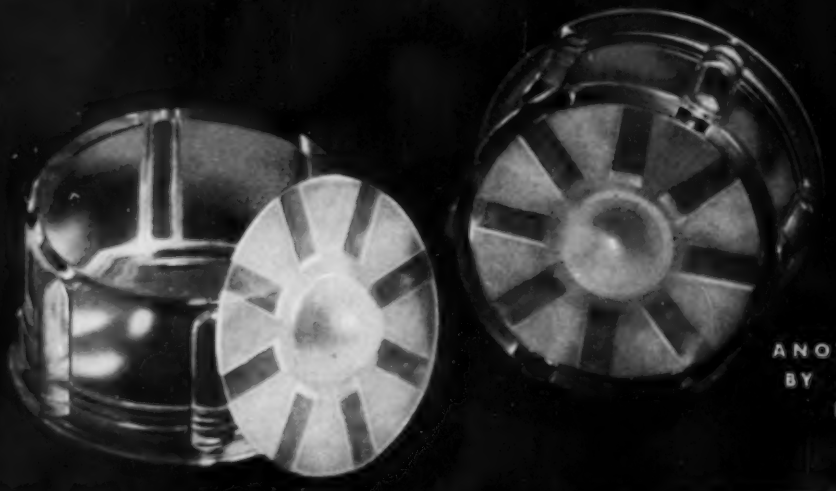
More on Chemical Engineers in The Textile Industry

CHEMICAL engineering has much which the textile industry should find useful. Consider this chemical engineering profession in some detail.

First of all: we are trained in certain unit operations. A process such as kiering can be broken down into several unit operations. Among these are: (1) fluid flow—the flow of liquor from the kier, through the heat exchanger, to the distributor, and through the goods; (2) heat transfer —heating the liquor, heating the goods, losing heat through the tank and pipe walls; (3) temperature and pressure control. Are you using the most economical fluid flow? Is your heat exchanger the most economically efficient? Could you save money by insulating any part of the kiering equipment? These are some of the questions we might help you to answer.

These, and many other, unit operations are the tools of a chemical engineer. With them, we can determine what factors of time, temperature, chemical concentration, etc., affect

LINERS
for new self-venting closures



ANOTHER NEW PRODUCT
BY A MOLDER USING A
DU PONT PLASTIC

molded of DU PONT POLYTHENE

These new acid-bottle closures are self-venting . . . may be used for liquids with high vapor pressures. Their resilient liners are injection-molded of Du Pont polythene. Because of the chemical resistance of polythene these liners have been used successfully with sulfuric, hydrochloric, and nitric acids. Manufactured by the Owens-Illinois Glass Co., the new closures meet I. C. C. requirements and have the approval of the Manufacturing Chemists Association.

POLYTHENE was chosen as the liner material for:

- **Chemical resistance**
- **Resiliency**
- **Low moisture permeability**
- **Toughness and flexibility**
- **No development of brittleness in storage**

In addition to these properties, Du Pont *polythene* is light in weight . . . won't shatter or smash . . . is tasteless, odorless, nontoxic. And it's readily molded and fabricated. *Polythene* may be an answer to *your* material problems. Write for specific data. E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 105, Arlington, N. J.

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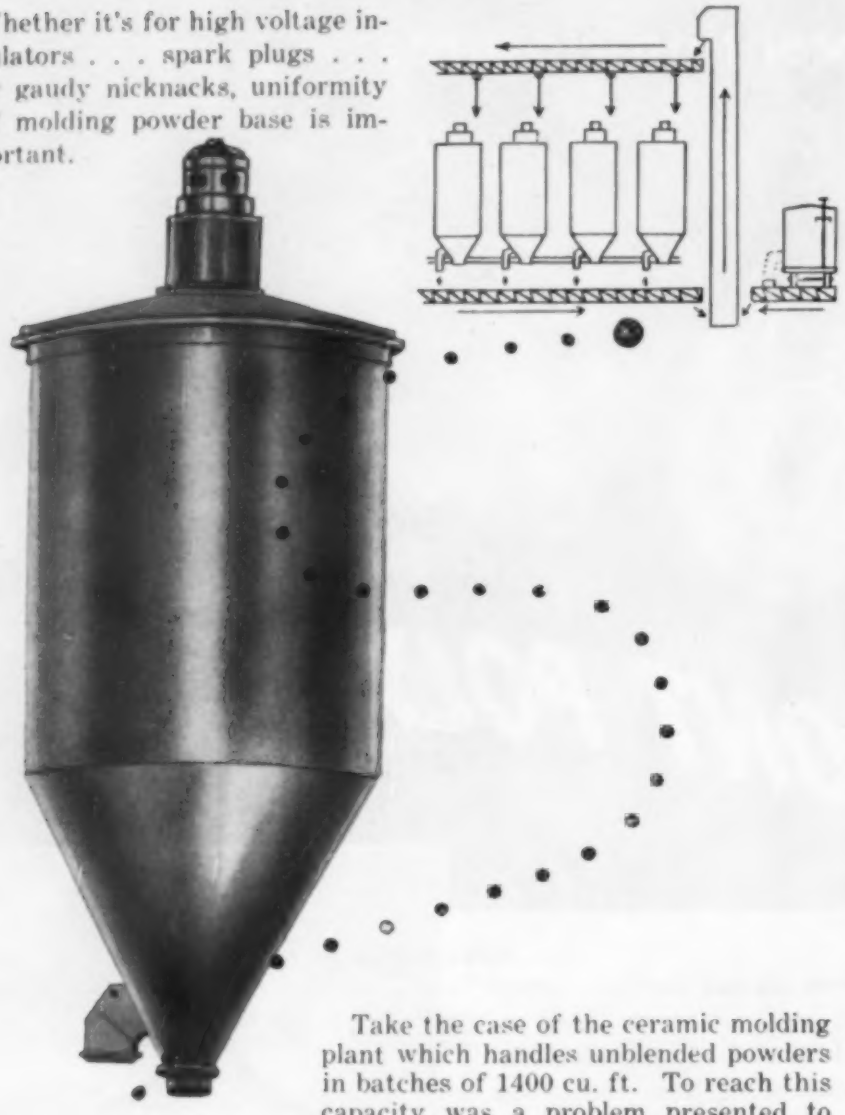
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

TUNE IN Du Pont "Cavalcade of America" — Monday nights — NBC coast to coast.

Continuous Blending

. . . a vital step in the manufacture of dependable ceramics

Whether it's for high voltage insulators . . . spark plugs . . . or gaudy nicknacks, uniformity of molding powder base is important.



Take the case of the ceramic molding plant which handles unblended powders in batches of 1400 cu. ft. To reach this capacity was a problem presented to Sprout-Waldron Engineers . . . solved through ADAPTIONEERING.

For years S-W Vertical Mixers had been furnished in capacities up to 150 cu. ft. So, four similar units, each of 360 cu. ft. capacity, were designed and built. These were made part of an engineered system of screw conveyors, percentage discharge feeders, and interlocking controls . . . all integrated into a 1400 cu. ft. Continuous Blending System.

Result: **Absolute uniformity of stock on a carload basis.**

25

If you mix, reduce, separate, or handle material in bulk, consult Sprout, Waldron & Co., Muncy, Pa.

SPROUT WALDRON
Manufacturing Engineers

the efficiency of a process, and within what limits they must be controlled. With them, we can scale-up a laboratory development to full-scale production. The increase in size of a process introduces problems arising from the size alone.

By the tools of unit operations, we can help the textile industry to make and save money. But, what is more important, is the policy with which these tools are used. A chemical engineer, in approaching your problems, will study first only those methods which are likely to be within your cost limits. This gives a different view of the problems we face. For example, the problem of waste disposal becomes the problem of waste recovery.

To summarize, the textile industry can use the following training and approaches of the chemical engineer: (1) Knowledge of unit operations and processes; (2) A training which considers production cost limits of primary importance; (3) Process design based on simplicity of operation; (4) Maximum use of all products of a process; (5) Full awareness of all factors which control a process; (6) Desire for the best over-all efficiency.

L. C. Leatherland, before First Annual Executives' Conference, Institute of Textile Technology, Charlottesville, Va., April 8-10, 1948.

Petroleum Varnish

A NEW type of varnish made from petroleum will ease the worldwide shortage of edible fats and oils. The new product is the first completely synthetic varnish.

Up to now, the so-called synthetic paints and varnishes have employed such natural products as linseed oil, soybean oil, and cottonseed oil as major ingredients. Since some of these natural oils also have food value, their continued use in non-food applications constitutes a drain on the world's food supply.

The new varnishes require no other raw material than petroleum. They are prepared from a new petroleum chemical developed in the Shell research laboratories. The products are particularly effective as industrial finishes on metal and as furniture lacquers, since they form insoluble films of very high mechanical and chemical resistance.

Glycerol allyl ether, the chemical used in the new varnishes, is a water-white liquid which is made from propylene gas in several chemical steps. Propylene is abundantly available from petroleum.

Glycerol allyl ether, by itself, is not a surface coating material. For this purpose it is reacted with certain acids such as those used in the manu-

Paired for Production!

HOUGH SAY "HUFF" **PAYLOADER** PATENT 2,412,323

and

PAYLOADER PATENT 2,412,323 **BUGGY**

Here is a profitable pair of production boosters for long-haul materials handling in the chemical and fertilizer industries — the well known, widely used Model HA Payloader Shovel and the new Payloader Buggy. Shovel and Buggy are teammates in every respect . . . are matched in power, speed and operation and also have interchangeability of almost all parts — an important service-economy feature for users of both units.

The Payloader Buggy has a capacity of 2 cu. yd. or 5,000 lbs. . . . carries any bulk material, dumps easily by hydraulic power. Payloader Shovels and Buggies have low height, rear wheel steer, short turning radius, large easy-rolling wheels, powerful hydraulic brakes and are easy to operate. They will travel through narrow aisles and in congested, low head-room areas. Information on the Payloader Buggy or any and all sizes of Payloader Shovels will gladly be supplied on request, also the name of your Hough distributor who sells and services these profitable, production-boosting machines.

SEND TODAY for bulletins on the Model HA 10½ cu. ft. Payloader, the ¾ yd. Model HF, the 1¼ yd. Model HL, the 2 yd. Payloader Buggy.

THE FRANK G. HOUGH CO.

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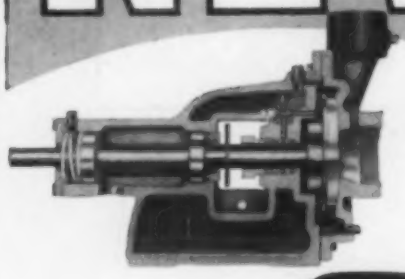
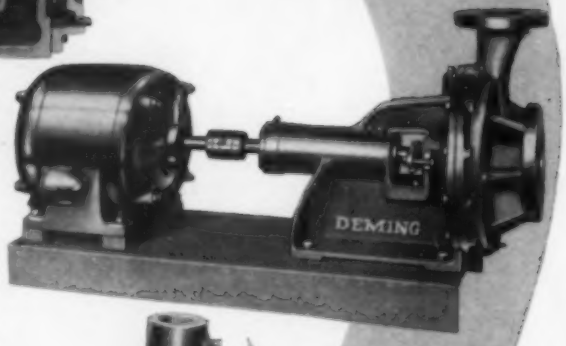
NEW ★

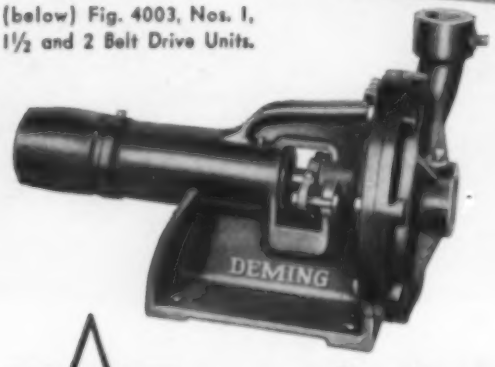




(above) Sectional view of Fig. 4003 Deming Side Suction Centrifugal Pump, Two Ball Bearing Type.

(right) Fig. 4023, No. 3 Motor Driven Unit.

(below) Fig. 4003, Nos. 1, 1½ and 2 Belt Drive Units.



★ and Available!

Designed for heavy duty service, these new Deming Side Suction, Two Ball Bearing Type of Centrifugal Pumps can be furnished for belt, electric motor, or gasoline engine drive. Sizes range from 1 to 6 inch discharge with capacities from 10 to 1200 gallons per minute. Important features of these new pumps and complete performance tables are given in the 16-page BULLETIN No. 4013-A. Write for a copy.

MEMO: The indicated demand for these new pumps suggest that you place your orders NOW to assure prompt delivery.

THE DEMING COMPANY
525 BROADWAY • • SALEM, OHIO

BULLETIN 4013-A

DEMING
THE COMPLETE LINE
PUMPS AND WATER SYSTEMS

fature of alkyd-type resins. These also are in general obtainable from petroleum. For example, phthalic anhydride from petroleum xylene.

While the synthesis of glycerol allyl ether requires specialized equipment, the reaction with the acid is a simple process and can be carried out readily by the varnish manufacturer who has modern processing equipment at his disposal. A variety of products can be prepared in this way, depending on the acid chosen. The varnishes obtained are particularly useful for applications which now employ resins made from a combination of synthetic materials and scarce natural drying oils.

H. Dannenberg, T. F. Bradley and T. W. Evans, Shell Development Co., before Division of Paint, Varnish and Plastics Chemistry, American Chemical Society, Chicago, April 23, 1948.

Jobs for Ex-Chairmen Of the Board

A MAN is more important than a walking textbook. With the great advent of retirement plans in the United States, there are probably many hundreds of able industrial executives retiring each year, quite a few of whom would be delighted to be on the faculties of universities and give their background of years of industrial experience, the thing which the professors largely lack.

Few of these men are much interested in money, so that the obvious objection is not valid. When we boil it down, we come to the conclusion that conventional teaching is not enough.

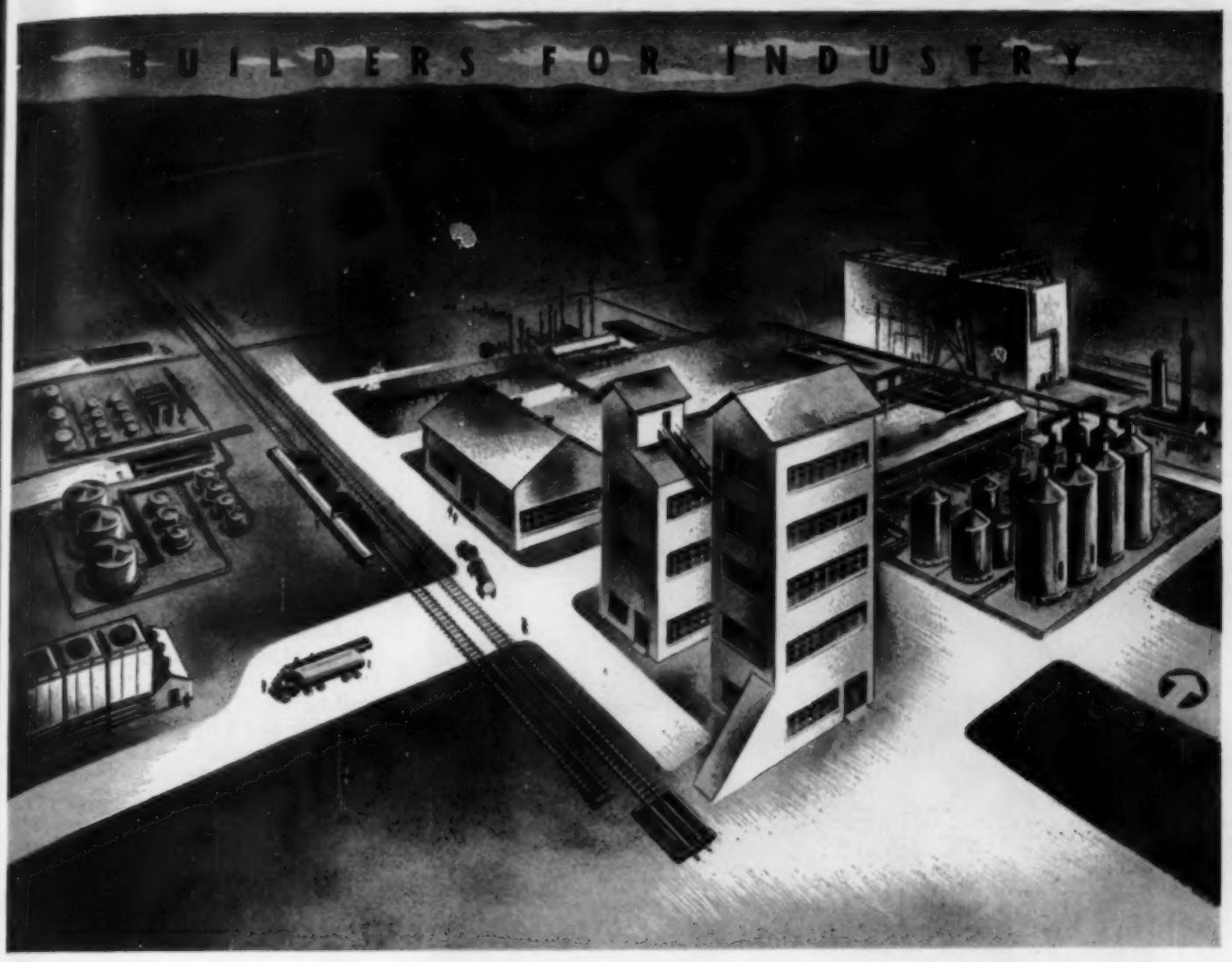
Broadening of the chemical profession has outrun education for it. Too much emphasis is placed on research and not enough on preparation of students for varied industrial careers. Industry must share the responsibility of education and training with schools and colleges. If the universities are to work on the production of the right kind of men, as well as of stuffed brains, the industrialist must take up part of the burden of training.

Francis J. Curtis, Monsanto Chemical Co., before Division of Chemical Education, American Chemical Society, Chicago, April 20, 1948.

Sound Analytical Procedure

SILENT sound waves have given chemists a new research tool for fast and accurate identification of complex liquid substances. The velocity of sound passing through a liquid is determined by the chemical composition of the fluid. This relationship can be calculated accurately in advance with the aid of mathematical formulas.

It is more convenient to utilize ultrasound instead of audible sound



The Comeback Of Coal

WHEN the need arises, American industry can process substitute fuels from coal. This will require vast plants, acres of gas works, utilities, chemical and refining facilities —integrated to operate as a closely knit unit. Basic information for these super plants is being worked out in such beginnings as the Bureau of Mines demonstration plant shown—Bechtel built for exact process control.

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for this purpose because, although ultrasound is pitched too high to be detected by the ear, it can be measured.

Investigations have been conducted on 20 substances with molecules consisting essentially of rings of carbon atoms plus, in some cases, oxygen, nitrogen, or sulphur. The studies have indicated that sound transmission is generally a more accurate means of identifying a liquid than refractive index.

Alfred Weissler, Naval Research Laboratory, before Division of Physical and Inorganic Chemistry, American Chemical Society, Chicago, April 21, 1948.

Too Much Too Soon

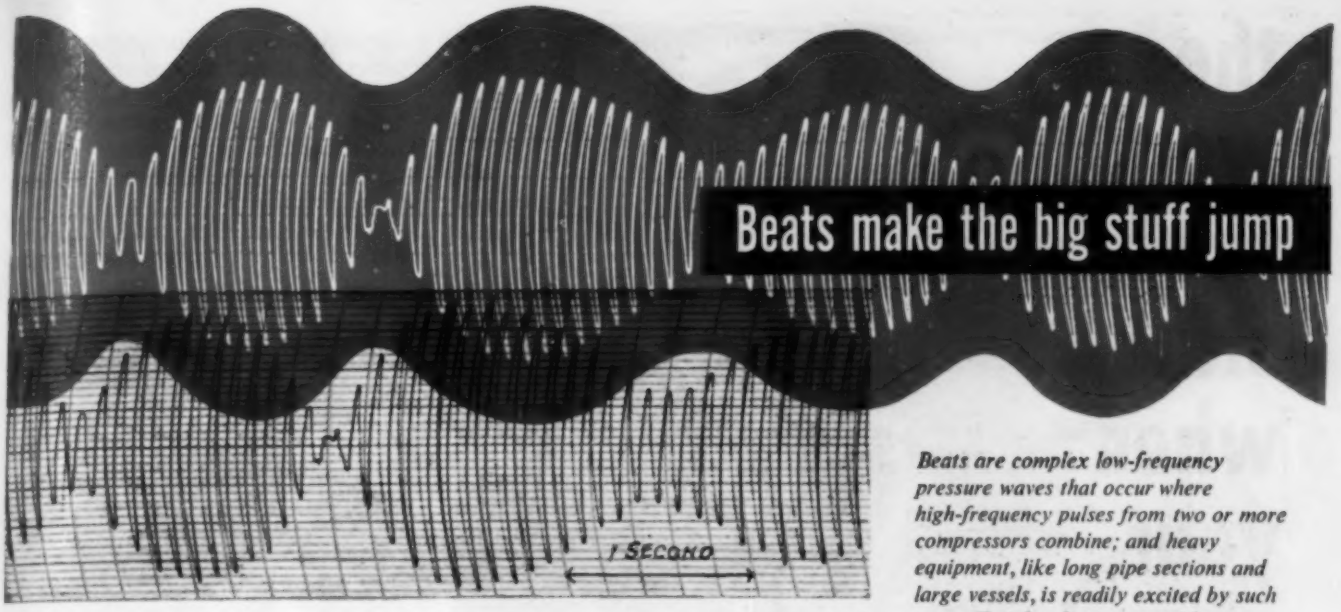
Basic research is the most difficult type of scientific endeavor for Americans who want quick and practical results. This quest for new fundamental knowledge has no end. The true spirit of science must receive the emphasis it requires to produce original thinking and discovery of new knowledge of the universe and less must be placed on the material aspects of science and technology. Pure scientific research is a creative activity involving observation, reflection, experimentation, and organization of knowledge and makes greater demands on the scientist's curiosity, intuition and imagination than on his faculties of logic and reason. By contrast, the military man is so concerned with winning tomorrow's battles with equipment available to him that he is apt to have little time or patience to consider what may be available to him in the remote future. It is essential that the two work together as partners, along with industry.

Maj. Gen. A. C. McAuliffe, Army General Staff, before Chicago Section, American Chemical Society, Chicago, Jan. 22, 1948.

Pure Oxide Refractories For High Temperatures

Refractories for lining industrial furnaces to operate at temperatures greater than ever before used commercially are now being manufactured on an experimental basis. "Pure oxide heavy refractory" brick of this class will withstand temperatures up to 4,200 deg. F., or 1,100 deg. above the top operating temperatures of the open hearth steel furnace.

Such brick are composed of one of the oxides of aluminum, or magnesium, or zirconium, and are characterized by high purity, hence their class name "pure oxide refractories." The oxides are electrically fused and crushed into grain, which is then formed into brick and fired at high temperature to develop strength by

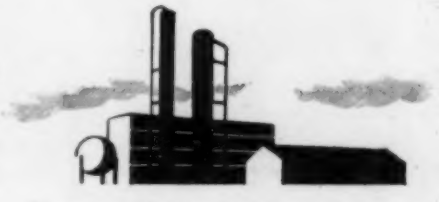


Beats are complex low-frequency pressure waves that occur where high-frequency pulses from two or more compressors combine; and heavy equipment, like long pipe sections and large vessels, is readily excited by such waves. So when beats occur, it's trouble ahead for the big stuff. (Chart shows one complete cycle of beats in a compressor suction system.)

Rx for Live Beats that should be Dead

Pulsation is potential dynamite Pulses from gas compressors prowl through pipes looking for conditions susceptible to their own frequency. When pulse frequencies and physical characteristics of the pipe are such as to establish a condition of resonance, destructive vibration follows. Failures in low pressure systems are serious; in high pressure systems they can be disastrous. Keep gas flow smooth and controlled with Fluor Pulsation Dampeners!

Pulsation also plays tricks It often makes orifice meters read wrong. It can cause excessive pressure drop in pipes. It can even cause a drop in compressor efficiency. But it does none of these things where Fluor Pulsation Dampeners are at work!



Fluor Pulsation Dampeners are built to fit each job: Any gas. Any compressor. Any pipe size. Any pressure drop.

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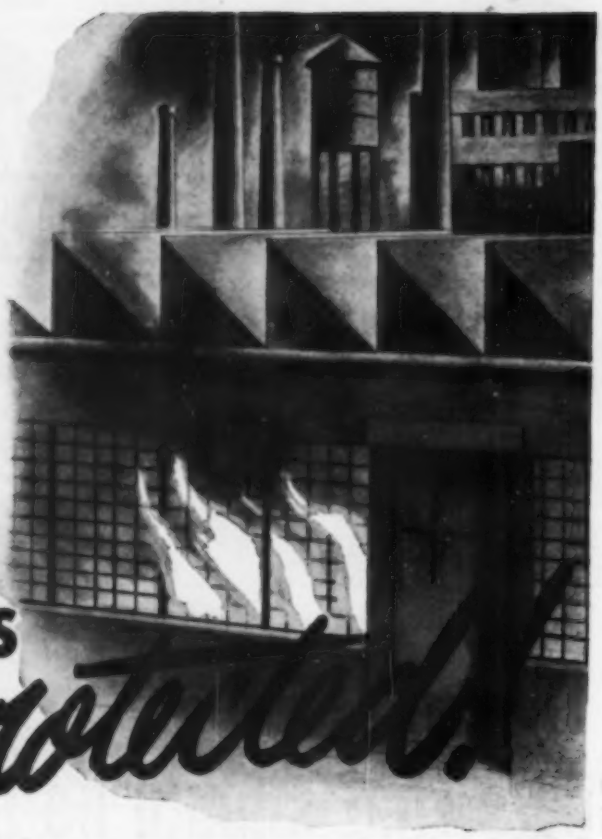
the worst fires start when your plant is unprotected!



Syracuse, Indiana — Trailer Mfg.
1 dead; $600,000

Fire, confined to a storeroom when discovered by the watchman, spread to stocks of paint and lumber in a large 1-story factory. A neighbor assisting firemen was trapped within the building.

Dee, Oregon — Warehouse
$205,000

Flames discovered coming from the roof of a large 1-story wooden warehouse by a watchman at 3:45 A. M. spread to 1,400,000 ft. of lumber stored in the yard of a nearby sawmill.

Marion, Ohio — Conveyor Mfg.
$350,000

Fire believed caused by a defective water cooler motor spread to painting material stores nearby. At 4:15 A.M., outsiders discovered the flames out of control in the large area 1-story building.

Reports of the National Fire Protection Association, month after month, show that the most costly fires start at night. The basis for this is logical; a small fire starts . . . there is no one there to spot it or to put it out... undetected, it grows rapidly . . . then the watchman, or often a passerby, discovers it . . . too late.

The new C-O-TWO Combination Smoke Detecting and Fire Extinguishing System is a 24 hour a day automatic fire watchman. It provides the fastest type of fire protection known. The first whiff of smoke in a protected area sounds an alarm. Then fast, clean, non-damaging carbon dioxide blankets the fire, putting it out in seconds, before it spreads and causes extensive damage. C-O-TWO is safe as well as highly effective on flammable liquid and electrical equipment fires.

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recrystallization of fine particles. Test pieces of these magnesium and zirconium oxide refractories can be heated to 4,200 deg. without noticeable shrinkage; similar aluminum oxide refractories can withstand 3,450 deg. temperature.

Each of the three oxide refractories has its own peculiar characteristics which must be considered for industrial furnace design. The aluminum oxide or Alundum brick, capable of lining furnaces operating to 3,450 deg. F., are very resistant to either oxidizing or reducing furnace atmospheres, conduct heat fairly readily, and are resistant to rapid temperature changes. Special light-weight refractories combine resistance to high temperature with excellent insulating qualities. The magnesium oxide refractories, while not resistant to reducing atmospheres or rapid temperature changes, are suitable for furnaces operating up to 4,200 deg. with oxidizing atmospheres. The zirconium oxide bricks are excellent heat insulators and are capable of use at 4,200 deg. in oxidizing atmospheres.

O. J. Whittemore, Jr., Norton Co., before American Institute of Chemical Engineers, New Orleans Feb. 17, 1948.

High-Temperature Insulation

DURING the war a need was created for an insulating material that could be used for protecting jet aircraft and their personnel against the high temperatures of the engine tail pipes which sometimes reached 2,000 deg. F. The insulation required had to be efficient, light in weight, and available in a form that could be easily applied to and removed from the equipment.

Silica, while capable of withstanding high temperatures, was not available in any form that could be used as a practical insulation. A research program was begun to develop silica into a form that could be used as a useful insulation material and from this was evolved silica in fibrous form. These fibers were made into light weight batts and textiles, which in turn could be fabricated into pads or blankets that could be wrapped around the hot pipes and fastened into place very easily. These pads met all necessary requirements.

Fibrous silica is similar in appearance and feel to cotton except that it is relatively fragile. The individual fibers are flexible and are exceedingly small in diameter being about three ten thousandths of an inch.

The new batted material has a thermal resistance that compares favorably with other high temperature insulating materials. This is especially interesting since the weight of the

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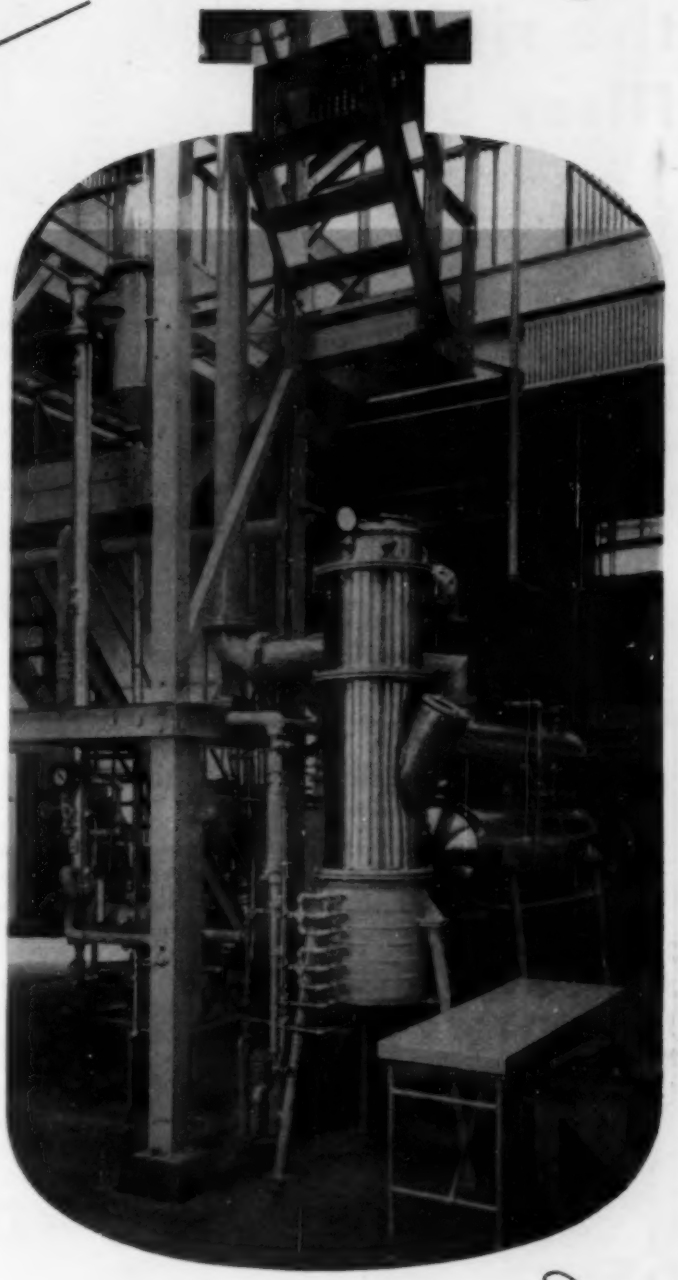

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fibrous silica is considerably lower than the other materials.

Considerable work has been done on developing more efficient insulation blankets using this new material. In a great many cases, it has been found that combinations of fibrous silica batt laminated with shiny metallic foils produce blankets that are highly efficient. The foils act as reflective surfaces for bouncing back heat in much the same way that ordinary mirrors reflect light.

While most of present day uses are for military purposes, industry has begun using this material in a number of ways. As high temperature insulation, pads that can be quickly applied and removed are beind used advantageously on equipment subject to frequent repair and inspection. Fibrous silica sleevings and tapes are used for covering electrical equipment to prevent grounding in applications involving high temperatures.

Leon Parker and J. J. Foster, H. I. Thompson Co., before American Institute of Chemical Engineers, New Orleans, Feb. 11, 1948.

Market Research Is Depression Insurance

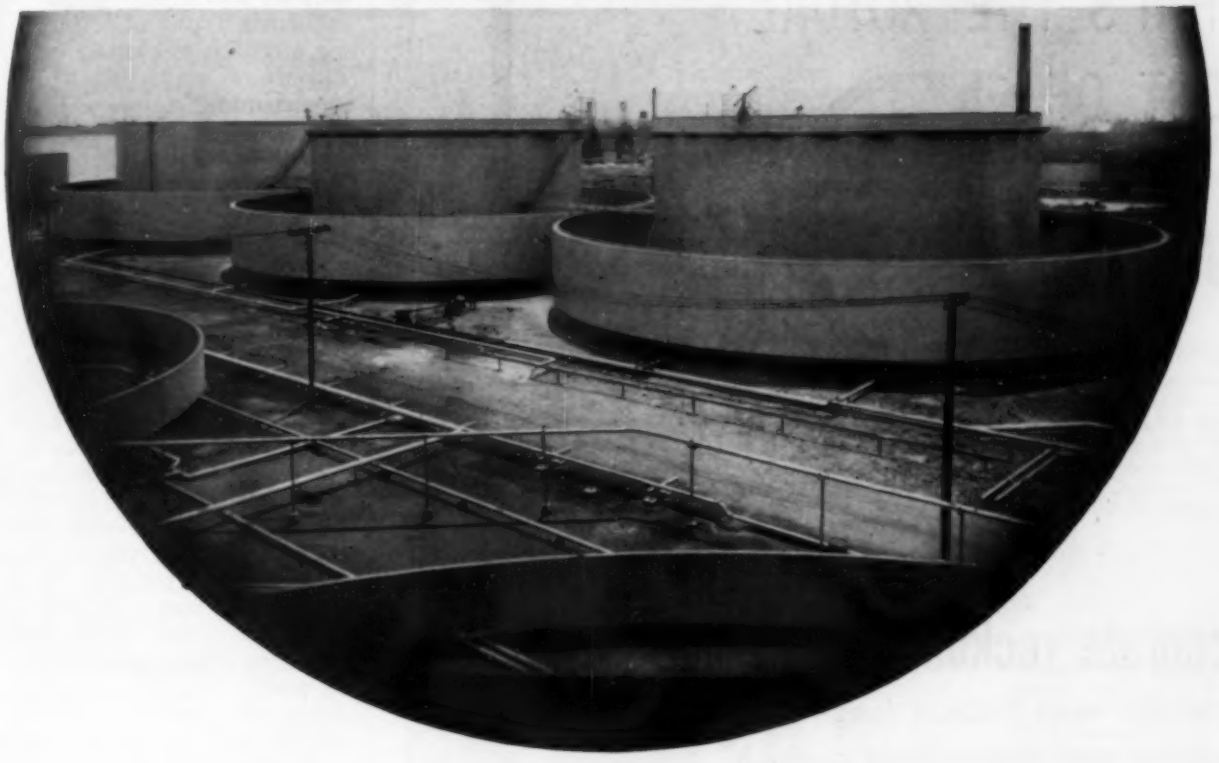
WHEN the next slump occurs in business, and competitive considerations compel the lowering of selling prices, those companies which are unable to trim their costs to meet the new situation will be in considerable danger.

Business should prepare now for such a contingency by introducing new products and by making improvements in old lines. It is necessary that an adequate job in market research be done before much time and effort are devoted to engineering research. Market research takes time; so does engineering research. Companies which wait until the next slump is on us to carry on the research necessary for the development of new or improved products will find that time is against them.

While most industries today have no difficulty in reflecting increased costs of production in higher selling prices, there is no assurance that this situation will continue. It is important, therefore, that these high production costs be carefully analyzed and studied with a view to seeing what economies can be brought about. Such economies may be accomplished through engineering research or through manufacturing research in better methods of manufacture or processing; new and better materials, better utilization of equipment, and so forth.

Increased attention should be paid to procedures for budgetary control

HORTON STEEL STORAGE TANKS with steel fire walls erected at eastern marine terminal



THE Sun Oil Company's Newark, N. J., terminal has a storage capacity of 17,000,000 gals. Four of the tanks holding about half of the terminal's total capacity are equipped with floating roofs to protect their contents from evaporation loss and to reduce fire hazard.

The three largest tanks at the Newark terminal have circular steel fire walls, as shown in the above photo. The five walls are 140 ft. in diam. by 22 ft. high and have butt-welded joints. They are mounted on concrete ring bases on piles and stiffened at the top by means of horizontal plate and angle girders.

Horton steel tanks of welded construction are widely used at chemical and process plants. Installations for storing volatile products are usually equipped with Horton Liquid-Seal Lifter Roofs or Horton Double-Deck Floating Roofs.

Horton flat-bottom steel tanks are built in capacities from 500 bbls. to 150,000 bbls. to meet your requirements. Write our nearest office for quotations.

Above: This view shows three Horton oil tanks 90 ft. in diam. by 48 ft. high, surrounded by steel fire walls. The two tanks in the foreground have floating roofs and the third one has a cone roof. Below: Aerial view of the Sun Oil Company's terminal at Newark. The three tanks with firewalls (which are shown in the above view) are located at the right in this view.

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Chicago 4.....2124 McCormick Bldg.	Philadelphia 3....1625-1700 Walnut Street Bldg.	Havana .....402 Abreu Bldg.
New York 6.....3318-165 Broadway Bldg.	Tulsa 3.....1623 Hunt Bldg.	Houston 2.....2103 National Standard Bldg.

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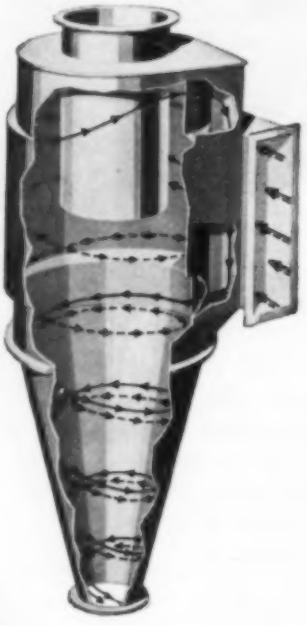
WHAT'S THE ACTUAL COST OF Dust RECOVERY?



Accurate reckoning

naturally must include long-range operation and maintenance costs. A good number of Buell installations, in a wide range of industrial uses, have been serving for 10 years with next to no maintenance. Operating costs are low with mechanical simplicity; no moving parts. Buell design eliminates plugging. And efficiency is high, because of the patented van Tongeren 'shave-off'. The Buell dust recovery system may mean real economy to you. Skim the facts or study the details in the new 32-page catalog. Write: Buell Engineering Company, 18 Cedar Street, New York 5, N. Y.

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Engineered Efficiency in DUST RECOVERY

as one phase of the matter of getting the business house in order before the next slump hits us. Practically all companies can do a more complete job of budgetary control than they are now doing. It should be so intimately a part of regular accounting procedure as to make possible the issuance of reports which serve both as accounting reports and as budget control reports. It should also facilitate the coupling of budget procedures with the general forecasting procedure.

C. E. Jarchow, International Harvester Co., before Controllers Institute of America, March 2, 1948.

Problems of Industrial Atomic Power

For the first time in history, the generation of power from the atom for peacetime use will be demonstrated at Brookhaven. This is expected within the next two years. Since the nuclear reactor is planned for research rather than for a power plant, the power generated will be a byproduct. Contracts are being negotiated for a steam plant which derives its power from the nuclear pile. The steam will generate electricity which will be used for driving cooling fans and other apparatus.

Before nuclear energy can meet with widespread use for industrial power, many problems requiring time, ideas, manpower and money must be solved.

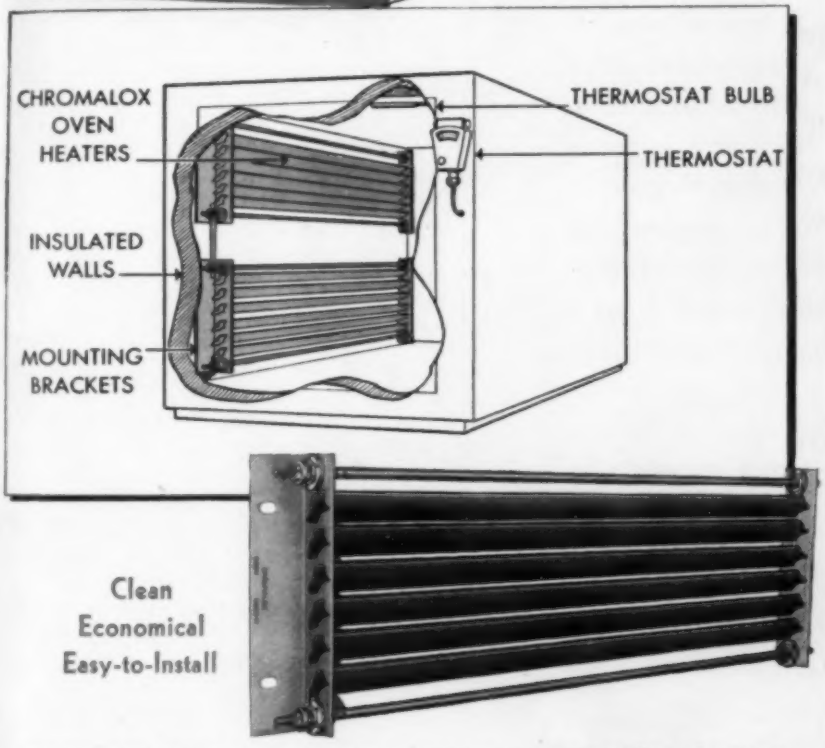
Among them is that of operating reactors at sufficiently high heat for the conventional heat engine. We have looked long and hard for a trick method of getting electrical energy directly from the chain reaction. We would greatly enjoy building a chain reactor with two wires leading out to carry away the energy at a modest voltage of a million or so volts. There ought to be a way of using this energy directly. We can get some energy from a reactor directly—in fact we normally control it by this means. We can even dream up a system by which we can achieve a reasonable efficiency. The only trouble is that such a system will not support a chain reaction.

So for we have learned no "open sesame." We acknowledge generally that electrical power, for the forseeable future, will be generated by means of the general heat engine. Using available materials satisfactory from a nuclear point of view, it has not been possible to operate reactors at appropriate temperatures.

A second problem has to do with the reprocessing at intervals of the nuclear fuel to remove the so-called "ash." At present this must be done

Increase production—Cut costs

in baking, drying, annealing and similar applications



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Heater is readily mounted on oven walls and easily connected to power lines.

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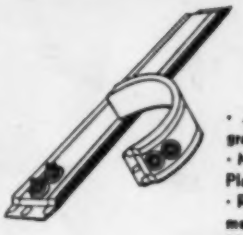

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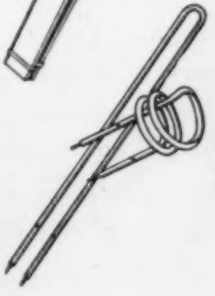

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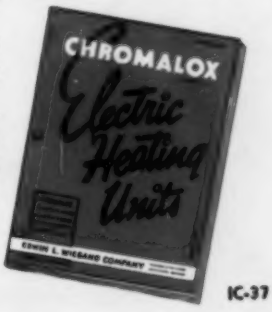

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"Varec" approved Internal Safety Valve, Fig. No. 507, with Flanged Connections
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behind thick concrete walls entirely by remote control.

A third problem has to do with fissionable material economy. In the utilization of uranium, only one atom in every 140 is the isotope U-235 which undergoes thermal neutron fission. The other 139 are all U-238 which absorbs neutrons to make plutonium. Principal reactors throughout the country are based on the fission of U-235 and therefore the use of this material is less than one percent efficient. Thorium is not used at all. Uranium is abundant in the earth's crust, but high grade deposits are rare. For a large scale power industry, we must learn to use U-238 as well as thorium. When this is possible we shall have enough raw materials to operate the nation's power plants for many centuries to come. Once again experiments, now under way, will tell us in a few years whether this is possible.

L. B. Borst, Brookhaven National Laboratory, before American Society of Mechanical Engineers, New Orleans, March 1, 1948.

How Much Detergents?

THERE are no reliable statistics available as to the exact production of synthetic detergents during the last few years. One can only guess as to the quantities involved. From a very modest beginning in the early thirties, by 1939 there was a yearly production of approximately 65,000,000 lb.—mainly higher alcohol sulphates. During the war years, the increase in production was small but since the end of the war, production facilities have increased very rapidly. Production capacity for 1948 is estimated to be approximately 700 million lb., the largest production starting with petroleum as a raw material. Future capacity will be goverened by (a) the demand created for the present synthetic detergents, (b) the development of new and improved products, and (c) an improvement in world conditions resulting in better standards of living, for history has told us that cleanliness is closely associated with standards of living.

Kenneth T. King, E. I. du Pont de Nemours & Co., before Association of American Soap and Glycerine Producers, New York, Jan. 29, 1948.

Zircon Refractories

IN THE past thirty years, a vigorous technical development of zirconium compounds has resulted in large and varied application for these materials. In the refractory field zircon, zirconium silicate, and zirconia have long been recognized as excellent superrefractory materials and further interest in these two materials is now

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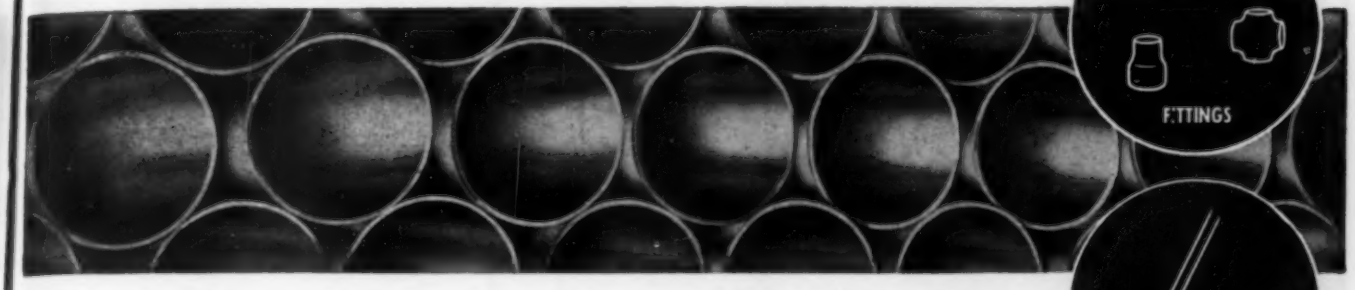

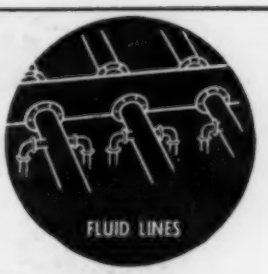

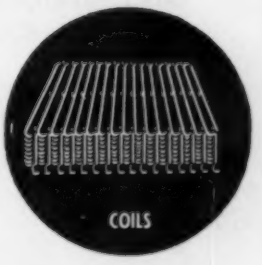

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In the past, the alloy has been available only in the cast form, known as Durimet 20. Now that Carpenter has overcome the problem of producing this alloy in the wrought form, its usefulness in solving corrosion control problems has been greatly increased.

There are two general types of applications in which Carpenter Stainless Tubing No. 20 can provide new and increased economy. First, in processes where sulphuric acid solutions are present at various temperatures and in various concentrations. And second, in handling other highly corrosive acids and solutions where an extra margin of safety is required, over and above the corrosion resistance provided by other types of Stainless Steel.

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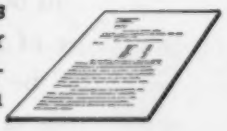
These data pages will give you useful information on the jobs that can be handled by Carpenter Stainless Tubing No. 20. For your copy, just drop us a note on your company letterhead, indicating your title, and ask for the Carpenter Stainless No. 20 Data Pages. We will be glad to put them in the mail for you.



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Carpenter Stainless Tubing No. 20 is also being produced in the forms of bar stock, wire and strip. For information, get in touch with The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

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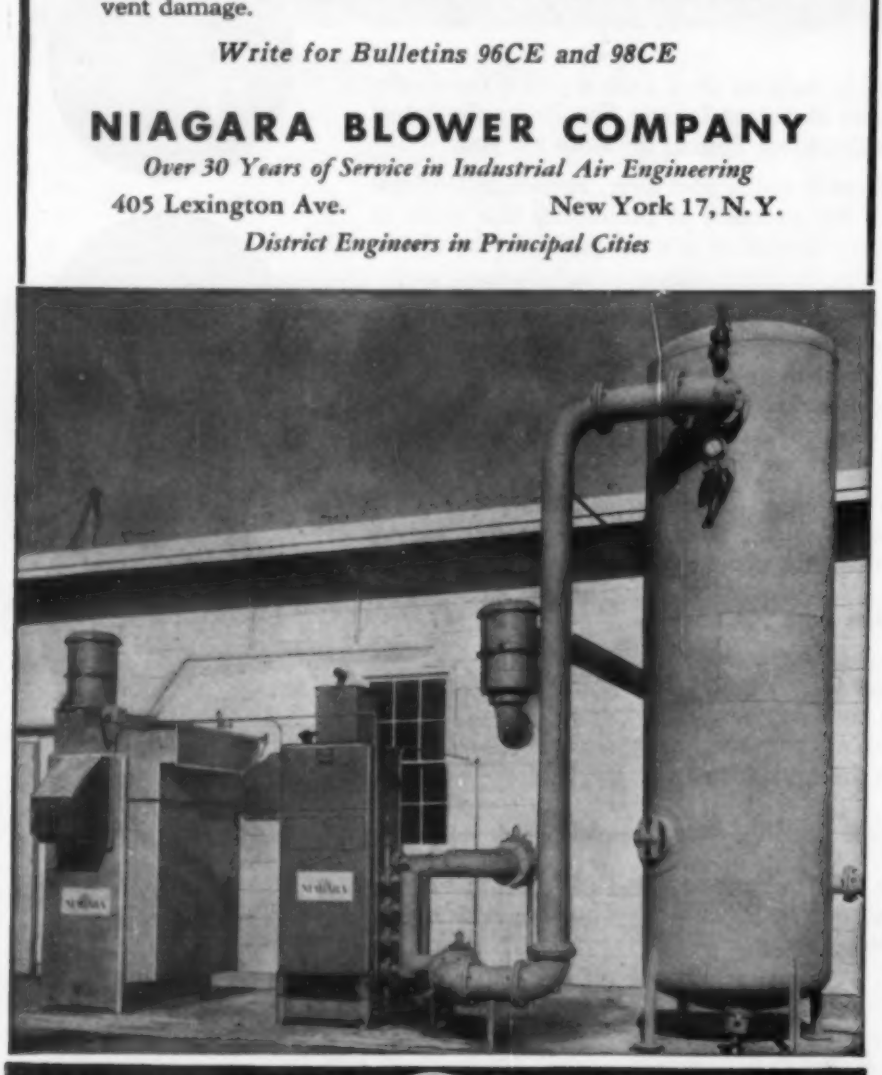

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evident as a result of the present day interest in liners for heat reaction motors where temperatures of 2,000-2,400 deg. F. and higher are obtained.

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In the case of zirconia these properties are advantageously intensified. Its extreme refractoriness, great chemical stability, white color, hardness, high resistance to reduction and general physical stability make it a material of unusual versatility.

Zirconia refractories have recently received further impetus through the recent development of stabilized zirconia. Ordinary ZrO_2 suffers from a pronounced volume inversion at 1,000 deg. C. The inversion and attendant poor thermal shock resistance are eliminated without reduction of fusion point by the use of small amounts of certain addition agents to zirconia. This refractory finds use at temperatures of 1,800-2,400 deg. C.

W. J. Baldwin, Titanium Alloy Mfg. Co., before American Institute of Chemical Engineers, New Orleans, Feb. 17, 1948.

FOREIGN LITERATURE ABSTRACTS

Chlorinated Rubber in the Textile Industry

Most important use for chlorinated rubber in the textile industry is in the preparation of fabrics which are both waterproof and fireproof. Fabrics impregnated with chlorinated rubber do not have the glassy, oily appearance of oiled fabrics of the same weight. Fireproofing is attained by the use of suitable plasticizers such as tricresyl phosphate or the chlorinated plasticizers: chlorinated naphthalenes, chlorinated paraffins, chlorinated diphenyls. The coated fabrics are used in the manufacture of tarpaulins and of special clothes. They have also been proposed for the cloth covering of airplane wings. The increase in weight of canvas after treatment is on the order of 16-18 percent, but the Americans use a method of impregnation with a chlorinated paraffin which gives a 60 percent increase in weight. A chlorinated rubber coating produces practically no weakening of the fibers on exposure to an arc lamp, providing, of course, that the chlorinated rubber

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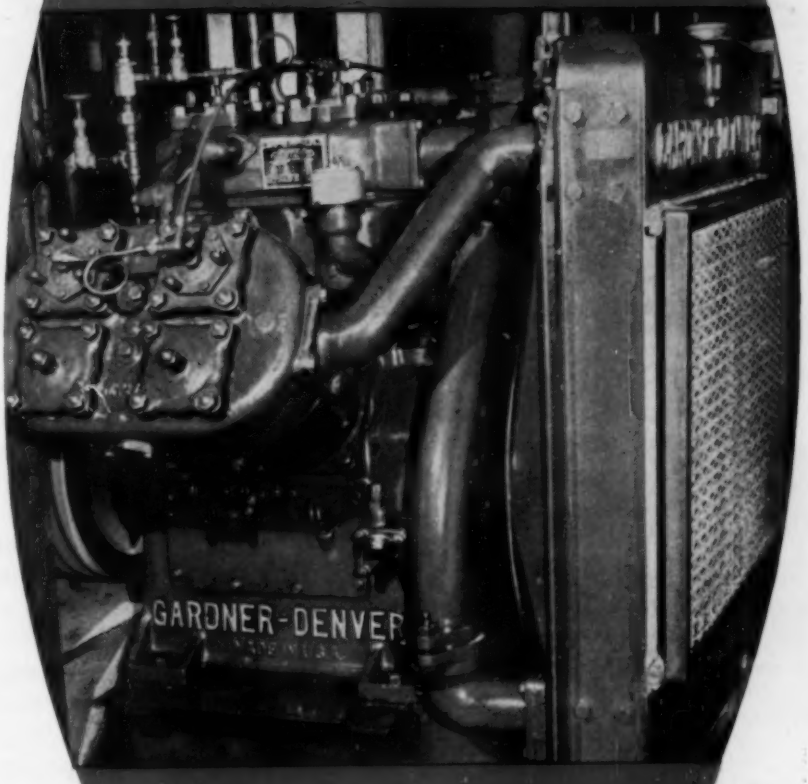

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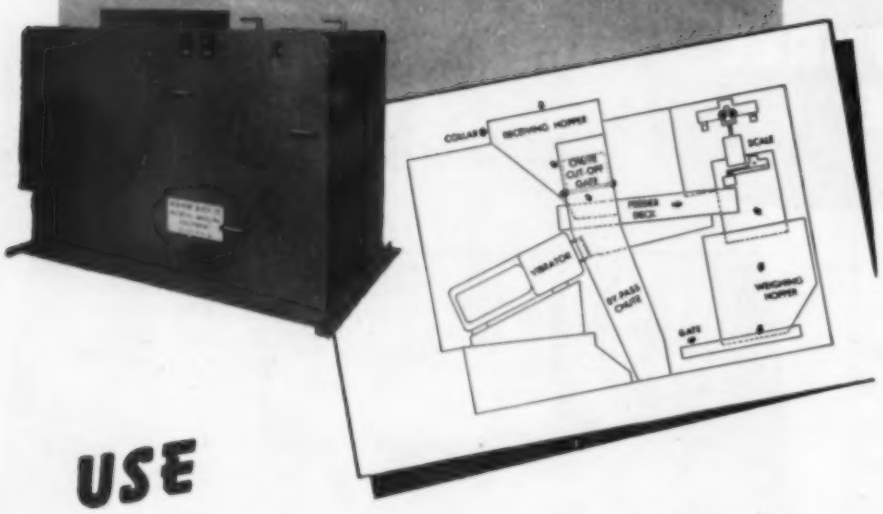

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is stable. Since chlorinated rubber sizings are resistant both to water and to bleaching agents used for linen, they have been considered for use in the permanent dressings of certain fabrics. The various formulas proposed involve the simultaneous use of chlorinated rubber and synthetic resins: vinyl or acrylic resins. The treated fabrics become supple during bleaching but resume their rigidity on application of a hot iron.

Digest from "Chlorinated Rubber" by Pierre Henry, *Recueil des Conferences, Journee Lyonnaise des Matieres Plastiques*, April 19, 1947, 29-53. (Published in France.)

Aluminosilicate Catalysts

ACTIVE aluminosilicates have a highly developed surface which bears a negative charge even after calcination at 850-900 deg. The dimensions of the surface and the charge are interrelated in most cases, since both qualities are dependent on the conditions of preparation of the aluminosilicate. Both reduction of the surface and decrease of the exchange capacity are noted when a catalyst deteriorates due to high temperature. The aluminosilicate should be entirely free from the cations of the alkaline metals and contain only active cations of the H^+, Al^{+++} and Th^{++++} type, in order that the disturbing action of the surface potential of the aluminosilicate be manifested on the neutral molecule.

Digest from "Relation between the Catalytic Activity and the Exchange Capacity of the Aluminosilicates" by J. A. Bitepazh, *Zhurnal Obshchei Khimii* 17, No. 2, 199-207, 1947. (Published in Russia.)

Mexican Coal Output

THE STATE of Coahuila is undoubtedly responsible for a large part of the 45 million tons of coal produced by Mexico from 1890 through 1944. Bituminous coal is also obtained, on a smaller scale, from deposits occurring in the states of Durango, Nuevo Leon, Tamaulipas, Queretaro, San Luis Potosi, Mexico, Hidalgo, Michoacan, Morelos, Puebla, Sinaloa, Veracruz, Guerrero, Oxaca and Chiapas. Lignite has been found in almost all the states which produce bituminous coal, as well as in Chihuahua, Colima, Jalisco, Tlaxcala and in such southern regions as Tabasco. Up to the present anthracite has come chiefly from the states of Sonora, Durango, Michoacan, Tamaulipas and Puebla. Now that Mexico is about to realize its program of improved industrialization, greater efforts will undoubtedly be made to find new deposits of coal for home consumption.

Digest from "Mexican Victory Minerals" by Eugenio Ysita, *Industria Minera* VI, No. 67, 64-67, 1947. (Published in Argentina.)

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FACTS ON FILTERING

Representative case histories on widely varied clarification problems condensed from field reports of Johns-Manville Filtration Engineers

One Hydraulic Press Load Convinces Jelly Maker

(reported by J-M Engineer T. A. Fouss)

FLORIDA DISTRICT: When I attempted to sell Johns - Manville Celite to this jelly manufacturer, the thought of putting a filter powder in his fruit to get more juice quicker seemed ridiculous to him. However, he took me out to see his press which was surrounded by split cloths and broken lattices—the result of attempting to get dry cheeses. His six press workers were spending most of their time scraping off the cloths and washing them in tubs of water. I suggested that he try a run with Celite.

A run was made, adding 1½% Celite 545 to the guavas at the cookers. Observers remarked that they had never seen the press close so rapidly or so far. On emptying the press, the cheeses were quite dry and one laborer could remove them from the cloths because they sheared off by gravity. No cloths or lattices were broken, the juice was noticeably free from suspended mud and the cloths were replaced in the press without washing.

Filtration Improved by Changing Filter Aid

(reported by J-M Engineer George T. Anderson)

SAN FRANCISCO DISTRICT: During a service call on a factory producing ethyl alcohol from wood waste, I learned that they first tried filtering their wort through a leaf press without a filter aid, and without success. They then experimented with adding Hyflo Super-Cel to the wort during filtration but it proved too slow.

I recommended a change to Celite 503. On the trial run, 60,000 gallons were handled in two hours through 650 sq. ft. of filter area. This improved performance more than met the customer's requirements.

Pre-coating Troubles Ended in Winery

(reported by J-M Engineer B. T. Humphreville)

CHICAGO DISTRICT: This wine maker had experienced some difficulty pre-coating a plate and frame filter and had been unable to get clarity. When I made a filtering run at the plant, I noticed that their pre-coat tank was too small and air was sucked out of the tank into the filter. Penetrating the pre-coat, the air caused cloudy wine to run through.

I suggested that an anti-splash pan be put under the return line at the pre-coat tank and that the level of the wine in the tank be kept higher. When this was done, they obtained clarity within two or three minutes . . . and filtration has been excellent ever since.

Hyflo Solves Problem in Tonic Plant

(reported by J-M Engineer C. A. Cocks)

NEW YORK DISTRICT: This tonic manufacturer always had difficulties in filtration. His original filter required 8 hours running plus 6 hours cleaning for each cycle. As a remedy, he purchased another type filter but was unable to get good results with it. After other filtration men had failed to help him, he called on Johns-Manville.

Making a test run with 1% of Hyflo Super-Cel per 1000-gallon batch, the writer obtained perfect clarity in 7 minutes and filtered the entire batch in 2 hours. Customer then decided to filter a 2000-gallon batch. Because the filter would not hold 200 lbs. of Hyflo, the percentage of filter aid was cut to 0.75%. A run of 2250 gallons was filtered in 4 hours and 20 minutes—which was little more than half the time previously required.

How to get help with your Filtration Problems

If you have a filtration problem of any kind, call in a Johns-Manville Filtration Engineer. Technically trained and thoroughly experienced, he can probably help you find the solution. He may find that a slight change in equipment, operating technique, method of adding filter aid—or a change to one of the high-speed Celite Filter Aids will increase production without affecting filtrate quality. A check-up of your filtering methods will cost you nothing and may save you money. Just address Johns-Manville, Box 290, New York 16, N. Y.

How to get clearest Filtrates at fastest Flow Rates

With Celite Filter Aids, you can write your own clarification formula. The various Celite grades, each a different degree of particle fineness, enable you to obtain the exact combination of clarity and flow required. Finer than the finest filter cloth, Celite traps out suspended impurities, allows only the clear liquid to pass through. For further information, write Johns-Manville, Box 290, New York 16, N. Y.

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CHEMICAL ENGINEER'S BOOKSHELF

Lester B. Pope, ASSISTANT EDITOR

Scales of Industry

INDUSTRIAL WEIGHING. *By Douglas M. Considine. Reinhold Publishing Corp., New York. 553 pages. $10.*

Reviewed by W. G. Hudson

A TIMELY book has been prepared by Mr. Considine. It fills a gap in technical literature by providing in one volume the basic principles involved in weighing mechanisms, the applications of the various types of scales, and information of recently developed industrial weighing equipment.

First section of the book covers the fundamentals of scale mechanics. This is followed by the theory of scale operation and a discussion of scales for basic weighing, "which constitute the great bulk of industrial scales in use today. By basic weighing is meant simple, direct, elementary weighing. As such it does not include those numerous other functions such as counting, automatic proportioning and controlling, integrating, etc." This section includes an analysis of the even- or equal-arm, bench, dial, portable platform, floor, suspension hopper, overhead track, motor truck and railroad track scales, and of scales equipped to provide printed weight records and predetermined lots.

The chapter on automatic weighers is of particular interest to materials handling engineers. It discusses the functioning of the Hardinge, Schaffer, Merrick, Richardson, Jeffrey-Traylor, Syntron and other feeder-weighers. It gives the characteristics of materials for which these mechanisms are suitable and the methods by which arching or other feed interruptions may be overcome. The text proceeds with the essential features of batch weighers and packaging scales, including several recently developed in this field.

In this chapter it would be well to point out that the electric vibrator does reduce arching with some granular and pulverized materials, but with many it merely compacts the mass—as with foundry sand. Aeration sometimes will work when vibration fails. A thin sheet (24 ga.) of stainless steel suspended in a hopper often will prevent arching. Moisture (p. 114) should be distinguished from surface moisture. It is the latter, not the inherent moisture, which affects the action of the mass of granular material. Another method for control of flow to a vibrating feeder (p. 116) is by varying the slope of the feed plate.

The point should also be made (p. 144) that in a weigher like the Merrick weightometer, it is essential that the carrying surface of the belt be cleansed of residual material. Otherwise this carries around repeatedly and invalidates the recorded weight. It might be mentioned that the Merrick Co. provides a length of roller chain of stated weight per foot. The scales is checked by fastening this chain so that it rides the weighing length of the belt and noting the readings of the dial. Thus a chain weighing 10 lb. per ft. resting on the belt has the same effect as a belt load of 10 lb. per ft. of material. If the belt speed is 300 ft. per min. the scale should record 3,000 lb. per min.

The specialist engaged in the design of weighing mechanisms will find in Chapters 7 and 8 the basic fundamentals and theory of scale mechanics and operation and the factors which determine the characteristics of a scale—its sensibility, accuracy, speed and useful life. Proper installation is emphasized together with the factors of maintenance which play so important a part in efficient performance.

Chapter 9 discusses the types of scales suitable for the heavy industries—mining iron ore, blast furnace operations, open hearth work, wire and sheet mills, foundries, etc. The discussion continues in Chapters 10 to 14 to cover the scales suitable for the chemical industry, public works, service and transportation, food production, textile and paper manufacturing rubber and plastics production.

This summary gives some indication of the completeness with which Mr. Considine has covered the subjects of design, construction and application of weighing mechanisms.

A complete glossary of "Scale Terms" is included, giving not only definition of terms used in this field, but of terms which engineers frequently employ, sometimes without too accurate an understanding of their exact meaning.

Training Aids

AUDIOVISUAL AIDS TO INSTRUCTION. *By William Exton, Jr. McGraw-Hill Book Co., New York. 344 pages. $4.*

Reviewed by Kenneth A. Kobe

"PURPOSE of this book is to make readily available, as fully and in as widely useful a form as practicable, the benefits of the experience of the armed forces in the creation of audiovisual materials for instruction purposes. The book is intended to serve as a textbook and a source for teacher and instructor training in both 'arts' and vocational education, and as a guide for those desirous of applying audiovisual procedures to training in industry." The author, Captain USNR, was assisted by a group of 13 section authors who were military personnel or civilians assisting in the training program of the armed forces.

What were the training objectives of the military forces during the war? The final objective of "Success in Battle" had to be reduced to the basis of the individual being trained. War-

time training is largely one of teaching skills and procedures, with a necessary amount of indoctrination to serve as a stimulant. The essential difference be-

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Cottonseed and Cottonseed Products. By A. E. Bailey. Interscience. $17.50.
Industrial Electric Furnaces. Vol. II By V. Paschkis. Interscience. $8.
Mineralogical Dictionary. By Chambers. Chemical. $4.75.
Synthetic Petroleum From the Synthine Process. By B. H. Weil & J. C. Lane. Remsen. $6.75.
Water Purification Control. 3rd ed. By E. S. Hopkins. Williams & Wilkins.

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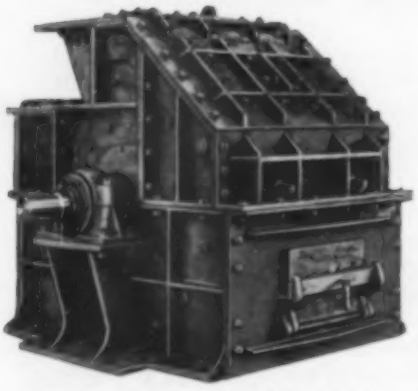

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tween military training and college training is the difference between doing and thinking. It is this lack of emphasis on principles which (along with personal inertia) causes the university professor to be skeptical of the merits of the training film, and this same skepticism is then attached to other training aids which could be used successfully in a university program. This skepticism is not justified (see the reviewer's article on "Army Training Methods Enter the Engineering College," *J. Engineering Education* 36, 66-72 (1945)).

The book is divided into five parts: Aids to Training, Projected Training Aids, Graphic Training Aids, Sound Training Aids, and Three-Dimensional Training Aids. In the first part (51 pages), the background, development and future of training aids are discussed, including Navy memoranda. Training films, film strips and slides, the projected training aids, are covered in the second part (43 pages). The condemnation that "in educational films the 'effectiveness' all too often sought is rather that of disguising the lesson as a Class B picture" is all too true. The training films issued later in the war had overcome this handicap, so that producers now should be able to make instructional and educational films without apology to the audience. The reviewer would desire a greater elaboration on the film strip, or slide film, which can be produced cheaply and used effectively in any training program. Graphic training aids (part three, 154 pages) deals with charts, maps, diagrammatic representations and illustrative drawings. It contains 144 illustrations of Navy graphics to show the variety of this type of training aid. Sound training aids (part four, 31 pages) are recordings which were used to teach auditory material, as bugle calls, Morse code (with interference) and languages. Three-dimensional training aids (part five, 47 pages) are models, both static and functioning. Their construction and value in the training program are shown.

Every industrial concern that makes any pretense of having an employee training program will expect the individuals concerned with its success to study this book with a view to translating to their particular concern the successful results achieved by the Army and Navy in their mass training program. If the Navy atmosphere appears rather thick at times the reader must remember that the military services brought to age the era of audiovisual training aids. This book is a challenge to the instructional staffs in institutions of higher learning to put aside their research, forthcoming book or

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bridge game, to study these new, effective methods of teaching and to try to adapt them to their own needs.

Biological Philosophy

LIFE, ITS NATURE AND ORIGIN. *By Jerome Alexander. Reinhold Publishing Corp., New York. 291 pages. $5.*

Reviewed by G. F. Kinney

A DISTINGUISHED scientist presents his views on the problem of the life process. A living unit is defined as one that can direct chemical changes by catalysis, and at the same time reproduces itself by autocatalysis. From this viewpoint, the viruses are living entities, and the definition of living unit may easily be stretched to include sterile hybrids such as the mule.

The story begins with the elementary particles of matter, and adopts the viewpoint that life began with the chance formation of a self-reproducing unit of molecular or near-molecular complexity. It is pointed out that this unit met conditions on a heretofore lifeless planet never since duplicated, and that this same unit would not necessarily survive under present conditions. It developed with changing conditions into complex organisms with sensitivity and intelligence. Related topics such as immunology, genetics, evolution, relation between science and religion, industrial catalysts, and the atomic bomb form part of the story. There are a large number of references, and numerous quotations and anecdotes enliven the material.

Fats and Oils

THE GERMAN OILSEED INDUSTRY. *By W. H. Goss. Hobart Publishing Co., Washington 15, D. C. 288 pages. $17.50.*

Reviewed by Gordon W. McBride

THIS BOOK resulted from a TIIC visit to Germany by a chemical engineer long engaged in soybean technology. The viewpoint of the author will appeal to processors of both edible and inedible oilseed products.

The chapters of this book were originally individual reports issued by the Office of Technical Services, U. S. Department of Commerce. The author has edited or rewritten all of these reports in the course of assembling them in book form. In addition to the original reports, there are included 51 photographs, 35 drawings, and 3 charts, one of which is presented for the first time.

Principal types of oilseed processing equipment and techniques are discussed in detail. Although many of

Right: Regulates speed of cooky machine to meet each change in operating conditions.

Below: Assures precision timing to meet changes in can size, product, etc., on closing machine.

REEVES Motodrive

Above: Provides infinite speed adjustability for spindle on tool room milling machine.

Above: Controls speed of pumps supplying chemical ingredients to blending and refining machine.

Combines motor, variable speed mechanism and gear reducer in single, compact unit

Widely applied to driven machines in all types of industries, especially where space is limited or where direct connection is desired, REEVES Motodrive provides machines with infinite, accurate speed adjustability to meet the requirements of every operating condition. The compact, self-enclosed unit is available in six sizes, covering capacities from ¼ to 15 hp and in speed ratios from 2:1 through 6:1. Helical reduction gears in ratios up to 189:1 may be incorporated to provide output speeds as high as 3,480 rpm. The Motodrive is built in both horizontal and vertical designs and may be equipped with either handwheel, push-button or completely automatic control.

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the photographs of the German plants show only ruined equipment, detailed drawings and flowsheets are presented in abundance.

Most of the leading oilseed mills and vegetable oil refineries in Germany are described in the chapters of this book. As a reference volume it will be essential on the library shelves of every organization interested in fats and oils.

From Switzerland

PHYSIKALISCHE CHEMIE. *Third edition. By Werner Kuhn. B. Wepf & Cie, Basel. 374 pages. 15 Sw. Fr.*

Reviewed by F. C. Nachod

DR. KUHN'S introduction to physical chemistry has been well received in Europe and now appears in its third edition. It is essentially a classical text and is aimed for all those who wish to understand the problems of physical chemistry without however making it their chosen field.

The chapters comprise introduction and definition of units, influence of temperature on physico-chemical systems, first and second law of thermodynamics, reversible reactions, dilute solutions, electrolytes, temperature dependence of equilibria (reaction isochore), third law of thermodynamics, reaction rates and photochemistry, surface tension and colloids. The only references given are more comprehensive texts, and no attempt to give specific literature is made as conforms to standard practice for introductory texts.

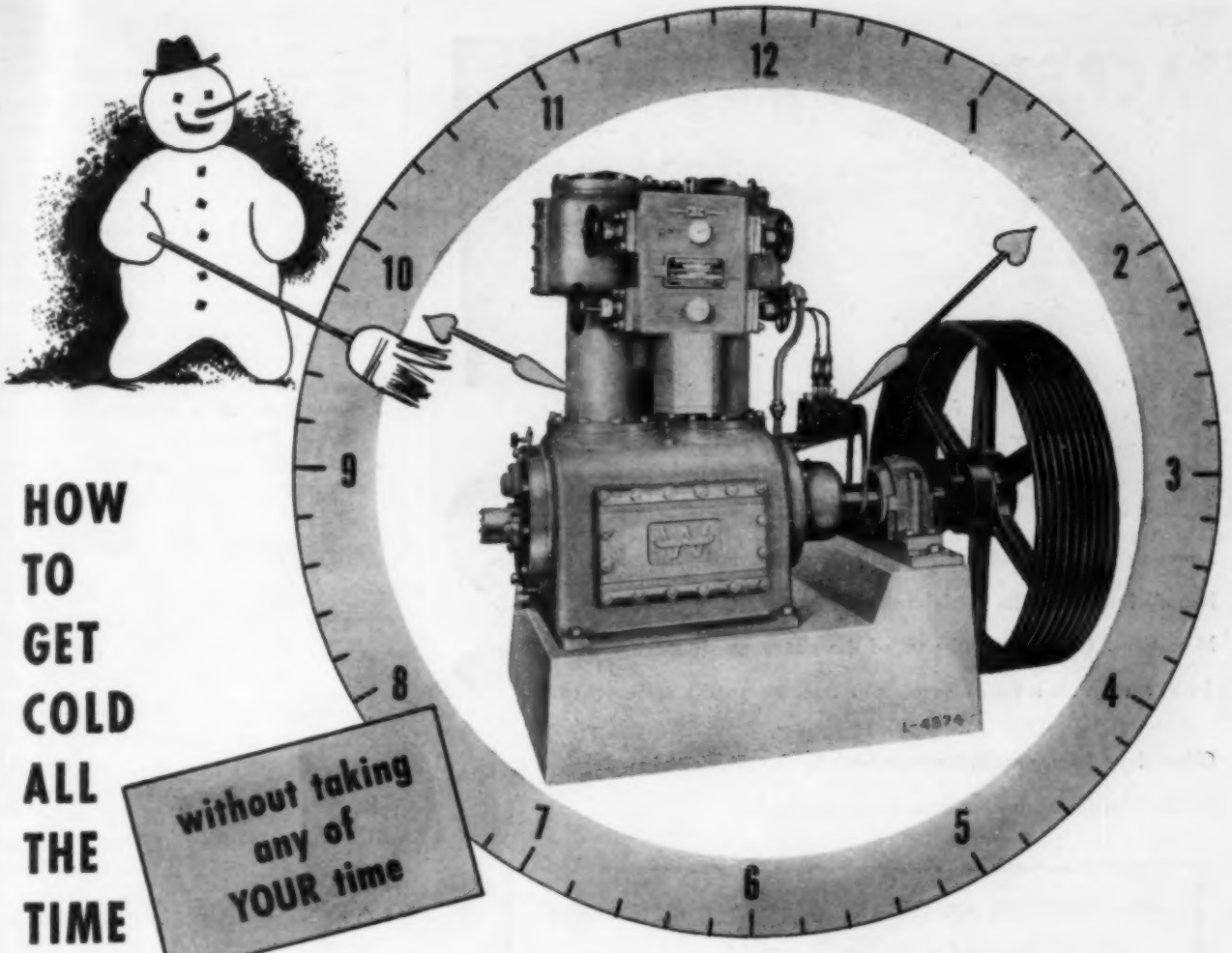
Usefulness of a text of this kind in English-speaking countries is of course limited. However, some of the portions could be well employed as reading material for graduate students to familiarize them with scientific German.

Sound Pedagogy

PRINCIPLES OF CHEMISTRY. *Fifth Edition. By Joel H. Hildebrand. The Macmillan Co., New York. 446 pages. $4.25.*

Reviewed by Joseph A. O'Connor

THAT its concentration upon fundamental principles of chemistry, which prohibits pleasant side excursions into the field of descriptive chemistry, is pedagogically sound has been proved by this book's widespread acceptance. The student is required to give undivided attention to chemical fundamentals, but Hildebrand's outstanding text, in the hands of a competent teacher, is an eminently flexible teaching tool. Treatment of new topics and revision of older material have brought this fifth edition completely up to date. New chapters on carbonic



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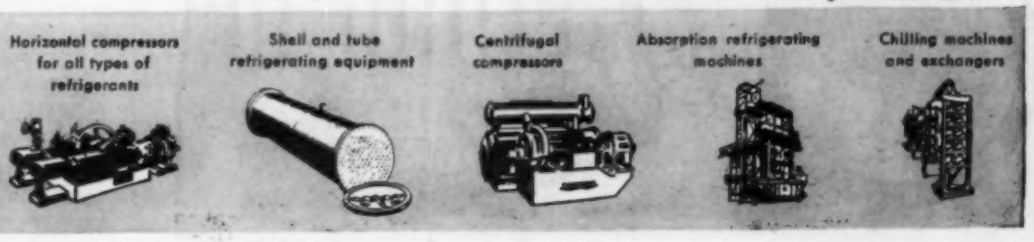
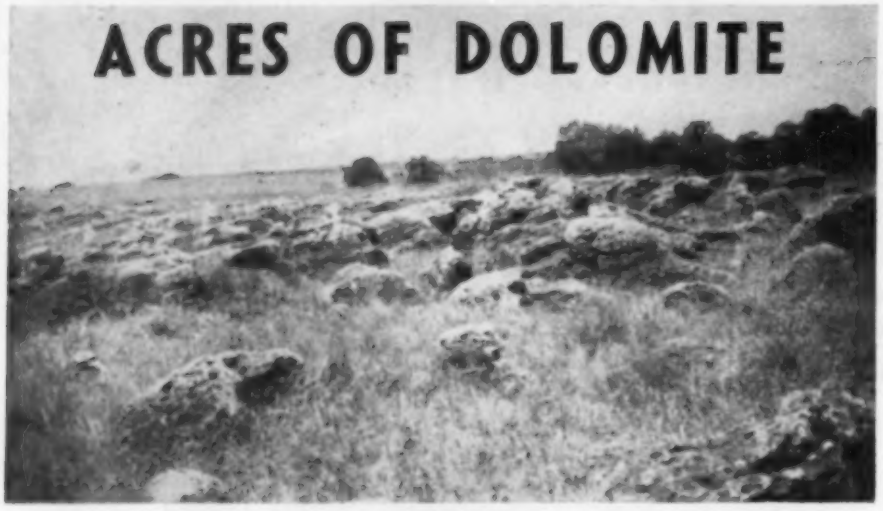

Horizontal compressors for all types of refrigerants
Shell and tube refrigerating equipment
Centrifugal compressors
Absorption refrigerating machines
Chilling machines and exchangers

ACRES OF DOLOMITE



Looming large in their potentialities for chemical utilization are Oklahoma's huge deposits of dolomite. In Murray County, in the Arbuckle Mountains, (south central part of the state) one deposit alone covers 1400 acres with a thickness of 550 feet. Its quality is very high.

Other deposits are available elsewhere in the Arbuckle Mountains, and in the Wichita Mountain area (near Lawton).

REPRESENTATIVE ANALYSIS OF OKLAHOMA HIGH-GRADE DOLOMITE
(Analyzed by Oklahoma Geological Survey)
ROYER DOLOMITE—MURRAY COUNTY
Representing 230 Feet Thickness

	Percent		Percent
CaO	30.680	Al_2O_3	0.170
MgO	21.350	P_2O_5	0.005
K_2O	0.053	S	0.010
Na_2O	0.028	H_2O @ 105°	0.050
SiO_2	0.300	Ignition loss	47.340
Fe_2O_3	0.150		
Total oxides	100.036		

Detailed information on Oklahoma's mineral resources is available on request, based on data by the Oklahoma Geological Survey. Map showing location of mineral deposits is also available.

acid and its ions, systems of acids and bases, and the structure of inorganic compounds have been included. Polymers, silicones, trans-uranium elements and recent discoveries in atomic structure have been dealt with in new sections. When its use is supplemented by use of a good descriptive chemistry text and a laboratory manual, Hildebrand's book serves admirably in teaching the introductory course in chemistry, particularly the course for students majoring in the field. It is also a convenient and useful guide that the practicing chemist, chemical engineer or executive might dip into occasionally to check up on some relatively simple but perhaps hazy point.

Encyclopedia of Volatiles

THE ESSENTIAL OILS. *Vol I. By Ernest Guenther. D. Van Nostrand Co., New York. 427 pages. $6.*

Reviewed by Edward Sagarin

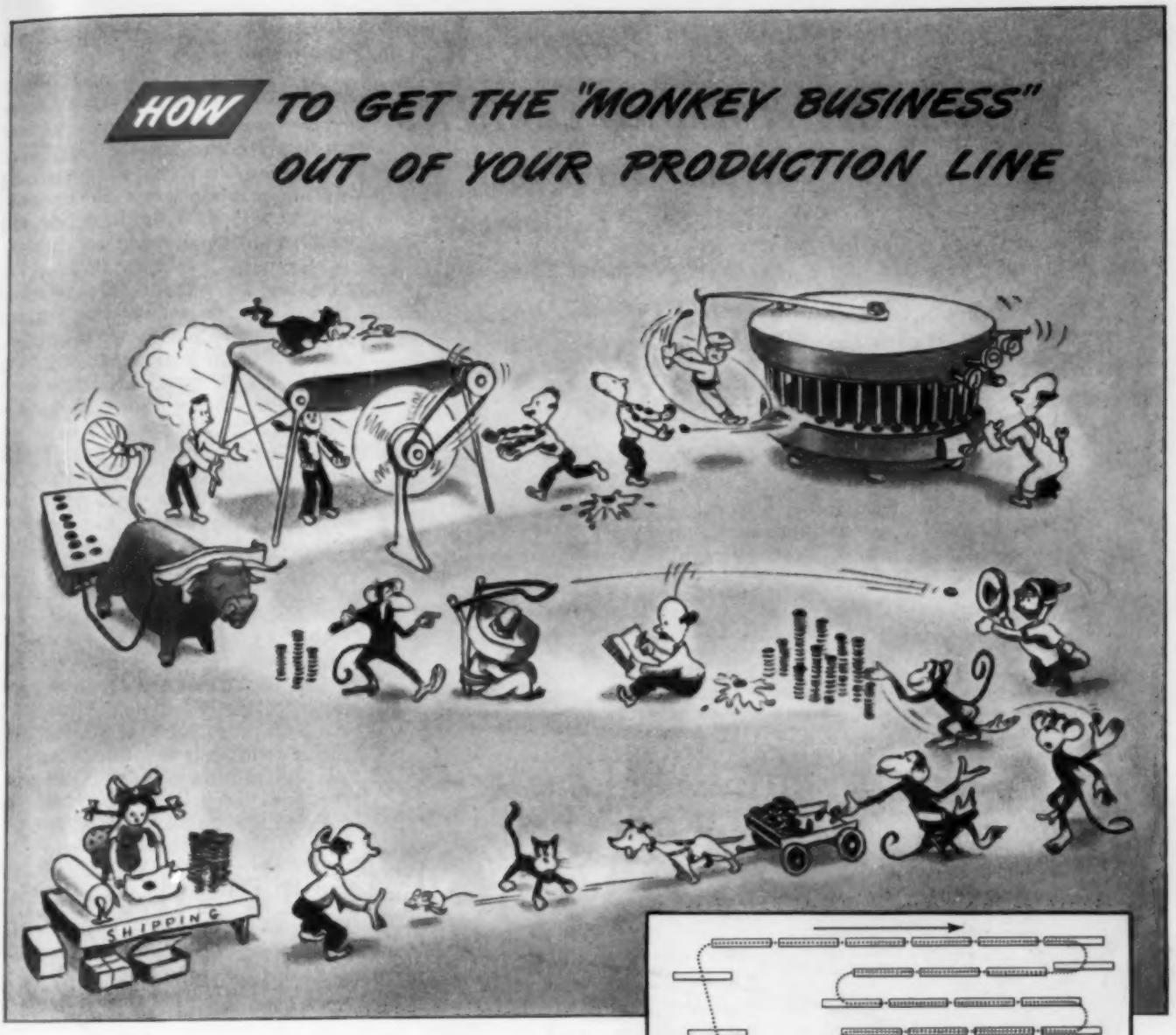
THE story behind a book may well be a key to an understanding of the place that a work will assume in a literature. This is surely the case with "The Essential Oils," of which the first volume of a projected series has just appeared. For some fifteen years, Dr. Guenther has been travelling to every spot on earth in which essential-oil bearing plants are grown, there to watch the agricultural and botanical aspects of the growth of the plants, to survey the diverse methods of distillation, to obtain samples of distilled oils of guaranteed freedom from the taint of sophistication.

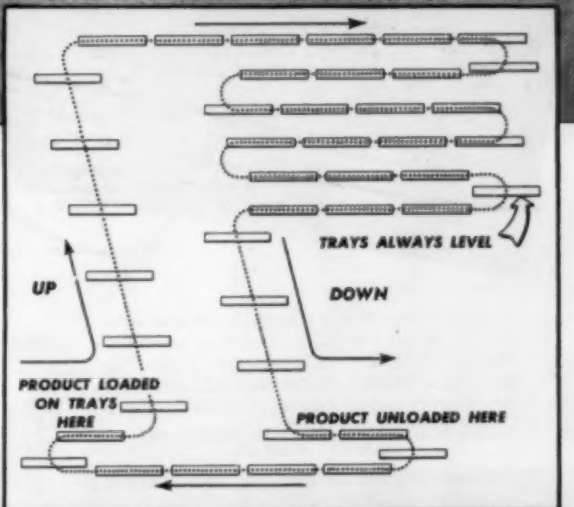
Into the jungles of Brazil, the interior of China, to the coast of Madagascar and the sunny climes of the French and Italian Riviera he has journeyed. The result has been seen in the hundreds of magazine articles on various individual oils, and now in the present volume.

For many years the standard text on volatile oils has been that of Gildemeister and Hoffmann; supplemented by works that never attained the success of Gildemeister, except that of Naves and Mazuyer in the specialized field of floral oils and other products of extraction. The need for a new and authoritative essential-oil reference work has long been recognized; there seems no doubt but that this book will, upon completion, become accepted as the encyclopedia of essential oils.

Dr. Guenther brings to this book not only the advantage of on-the-spot investigations, the assurance that his descriptions are based upon unadulterated samples and oils, but the wealth of chemical and botanical advancement that science has made since

HOW TO GET THE "MONKEY BUSINESS" OUT OF YOUR PRODUCTION LINE





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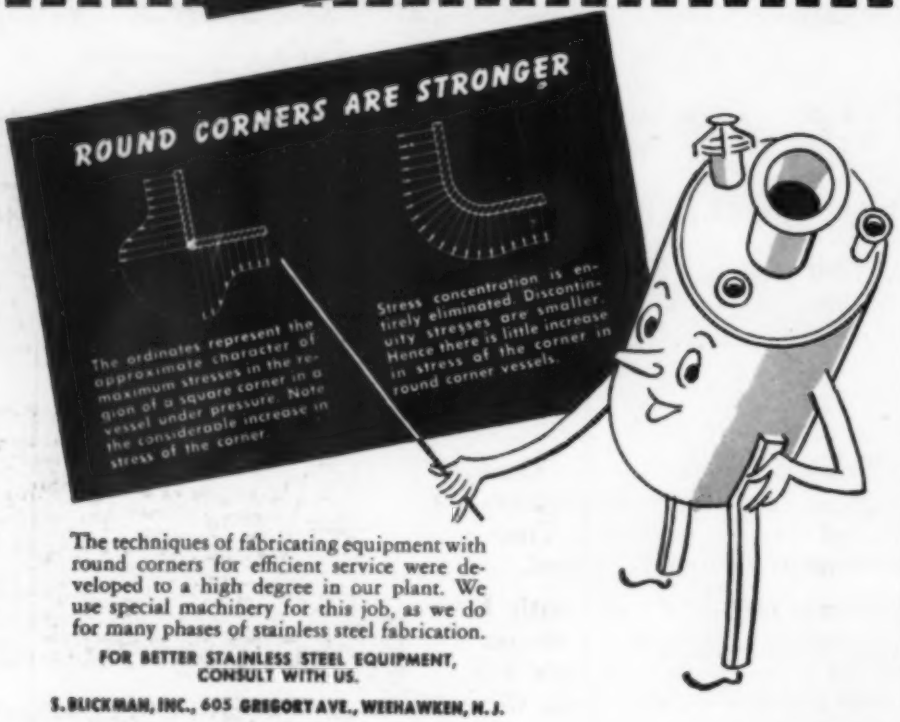
Even the best brushes require extra time to clean accumulations gathered in square corners. With gummy material or material that hardens, complete removal may never be possible.
In Blickman round corner construction the brush has no difficulty in cleaning the entire surface of the round corner. This saves time and reduces the danger of contamination and corrosion.


ROUND CORNERS ARE STRONGER
The ordinates represent the approximate character of maximum stresses in the region of a square corner in a vessel under pressure. Note the considerable increase in stress of the corner.
Stress concentration is entirely eliminated. Discontinuity stresses are smaller. Hence there is little increase in stress of the corner in round corner vessels.

The techniques of fabricating equipment with round corners for efficient service were developed to a high degree in our plant. We use special machinery for this job, as we do for many phases of stainless steel fabrication.

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the publication of previous studies in this field.

Although the major part of the succeeding volumes will consist of monographs on individual essential oils and on their constituents, the first volume is more introductory in scope, covering the origin and history of the essential-oil industry, the oil in the plant, and production, examination and analysis of the oils. For this purpose, Dr. Guenther has obtained the collaboration of several competent authorities, whose contributions enrich his studies, and in his own section on distillation, he has drawn liberally from the relatively little known work of von Rechenberg.

Because of the great contribution the essential oil industry has made to the development of distillation, and because of the attention to progress in distillation given by the industry and by this book, it will have an appeal to organic chemists and chemical engineers who may not be concerned with the production or use of volatile oils.

We regret that the bibliographical references are scattered throughout the book, and that they are made all the more difficult to locate because of a lack of an authors' index. Otherwise, the book is well indexed, and the material well arranged.

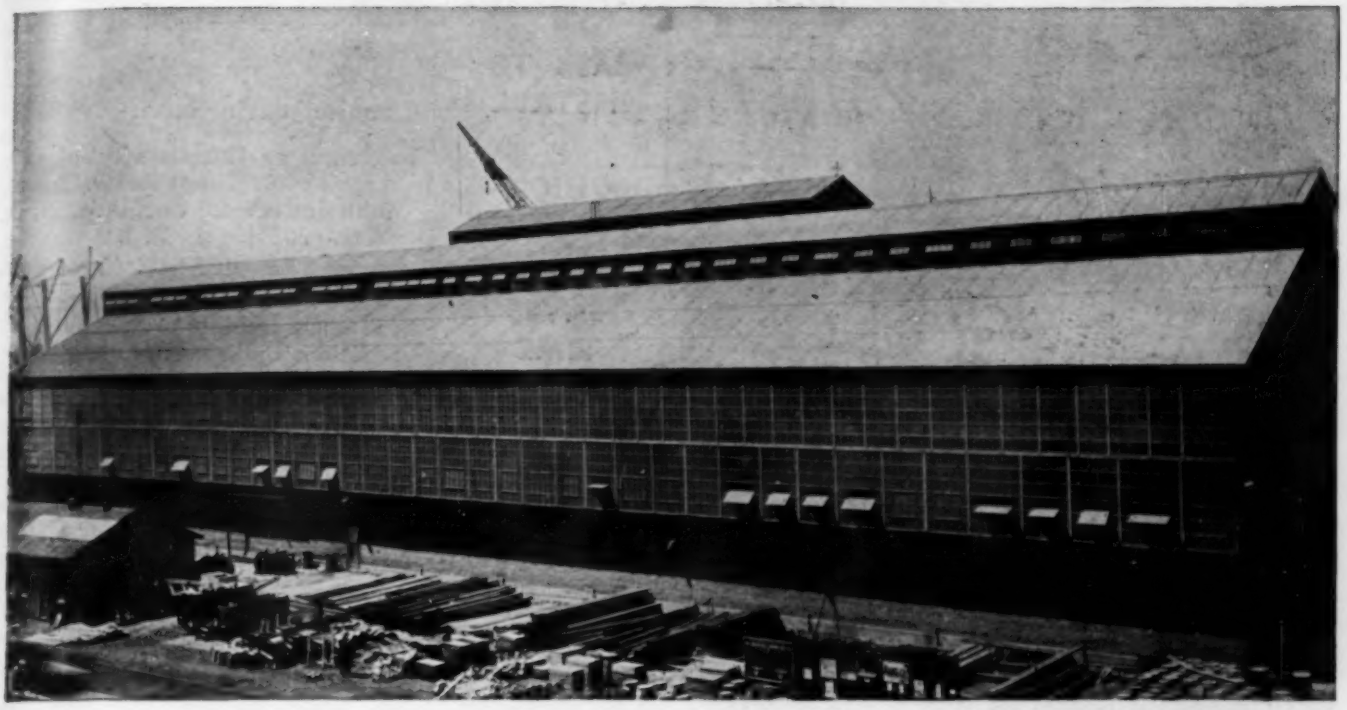
For 95 Percent

PRESSURE VESSELS FOR INDUSTRY. *By Harry M. Spring, Jr. McGraw-Hill Book Co., New York. 259 pages. $3.50.*

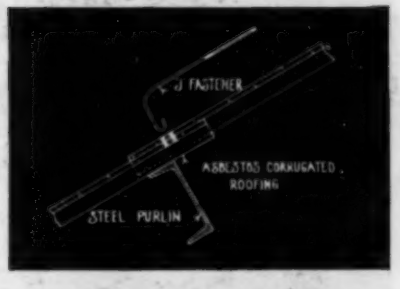
Reviewed by Donald F. Othmer

THIS is neither a text nor a treatise on the subject of design and use of pressure vessels. It is a handy little reference book intended "to aid the engineer or master mechanic as well as the student, to tie in parallel problems in boilers and pressure vessels." The subject matter is divided by uses to which the vessels are to be put, i.e., compressed air, steam and hot water, pulp & paper mills, rubber industry, textile industry, chemical industry, and specialized services. In these chapters, the particular problems of each industry are discussed with photographs, flowsheets, and detail drawings of equipment which has been developed to fill the specific needs of that industry. A short resume (50 pages) of design and fabrication fundamentals, is followed by a section on appliances and accessories for pressure vessels and an interesting chapter on Defects—their Hazard, Prevention, and Repair. While this does not represent all that is known or written on this subject (and the many corollary aspects of the several industries) it does

K&M "Century" ASBESTOS CORRUGATED



Details of one of the new TOP-SIDE Fasteners exclusive with K&M "Century" Asbestos Corrugated for roof installations.



NUT
STEEL WASHER
LEAD SEAL
AFTER LEAD SEAL IS SEATED BY TIGHTENING NUT, BREAK OFF EXCESS ROD, AND BEND LEAD APRON OVER EXPOSED END
ASBESTOS CORRUGATED ROOFING
J FASTENER

RESISTS CORROSION
right on the water front

The roof of this huge ship-building plant has to take a tough beating from the corrosive atmosphere of the river front. Thus it was natural that K&M "Century" Asbestos Corrugated should have been specified as the roofing material . . . for this durable asbestos-cement product is inherently immune to corrosion.

Of course, resistance to corrosion is but one of "Century" Corrugated's good points. It is completely fire-resistant. It won't rot . . . nor is it affected by the elements. Time only toughens it . . . no painting or other upkeep is needed.

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If you are planning any remodeling or new construction, it will pay you to look further into the advantages of "Century" Corrugated. Write for full details.

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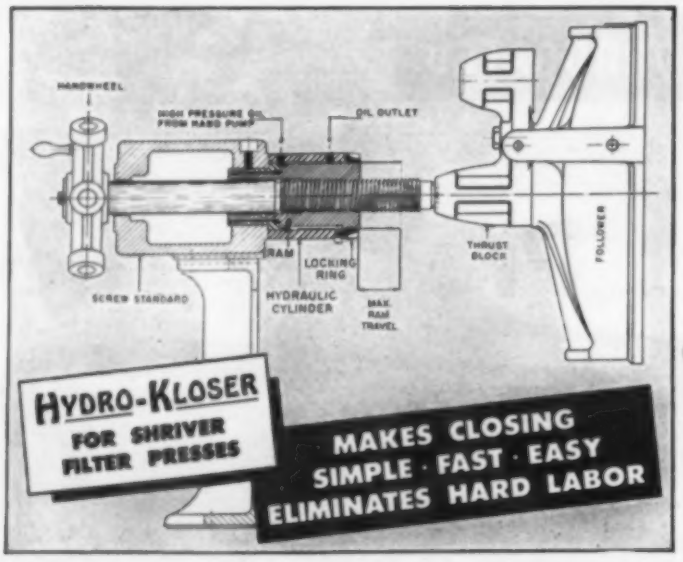

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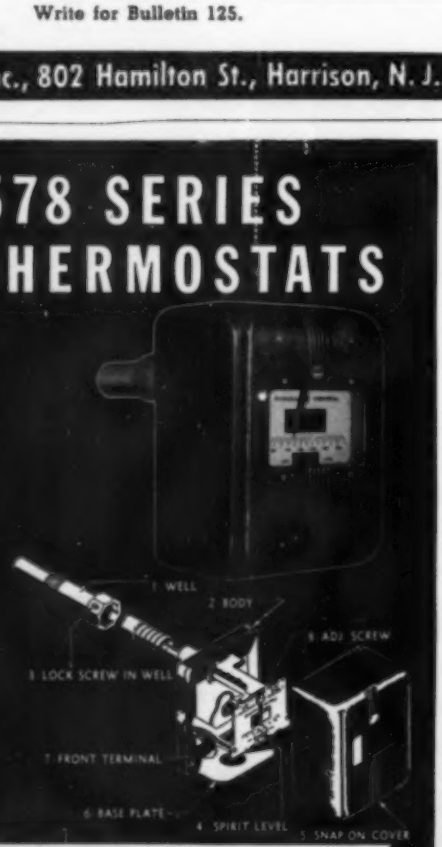

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assemble in a useful form most of the material that about 95 percent of the practicing engineers will need to know about pressure vessels. Mechanically and pictorially the book is excellent (exactly one photograph or drawing per page).

Chemical Architecture

FRONTIERS IN CHEMISTRY. Vol. V. *Edited by R. E. Burk and O. Grummitt. Interscience Publishers, New York. 202 pages. $4.50.*

Reviewed by F. C. Nachod

THE Western Reserve lectures are again made available to a larger public. Editors Burk and Grummitt have aptly chosen the title: Chemical Architecture. The six main sections comprise: Applications of molecular geometry in the field of reaction mechanism, by Hugh S. Taylor; Dipole moment, resonance and molecular structure, by Charles P. Smyth; Structure of co-ordination compounds, by W. Conrad Fernelius; X-ray studies of randomness in various materials, by B. E. Warren; Light scattering in polymer solutions, by H. Mark; and The nature of inorganic gels, by Miroslav W. Tamele.

While all papers are of the high caliber one might expect from the respective authors, special mention is due to a very excellent discourse on co-ordination compounds stemming from Dr. Fernelius.

The British View

ATOMIC ENERGY, ITS INTERNATIONAL IMPLICATIONS. *A Discussion by a Chatham House Study Group headed by Sir Henry Dale. Published by the Royal Institute of International Affairs, London. 128 pages. 4s. New York publications office, 542 Fifth Ave., New York 19, N. Y. $1.25.*

Reviewed by S. D. Kirkpatrick

NUMBERED among the distinguished contributors to this little publication are such scientists as professors Sir James Chadwick, J. D. Cockcroft, M. L. E. Oliphant, R. E. Peierls and C. E. Tilley and such political and industrial leaders as Sir Arthur Salter, Lord Hankey, Sir Oliver Franks and Dr. Cecil H. Desch. Appointed by Lord Astor in September 1946, the group spent a year in studying the problem of atomic energy and its effects on international relations. Their report has its chief value to American readers in bringing together different viewpoints than those commonly met in this country. Our scientists and engineers may have to swallow hard occasionally when they find how successfully the American contribution

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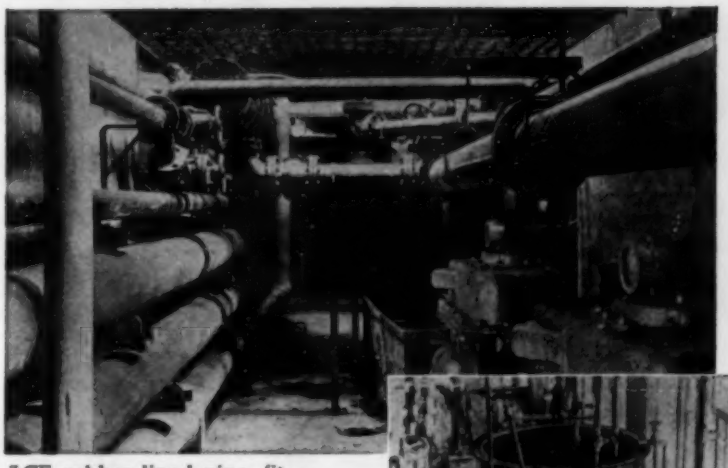
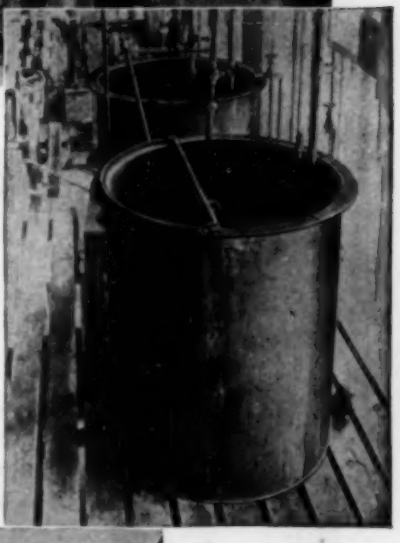


ACE rubber lined pipe, fittings, valves and tank, and ACE all-hard-rubber pipe and fittings are used in this one installation



Several of these ACE rubber lined tanks are used for caustic and bleach storage in one bleachery

Abrasive, acidulous water is handled by this ACE pipe lined with ¼" soft rubber, in service more than 8 years

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has been minimized. But its scientific and technical backgrounds, the raw material and mining problems and possibilities of peaceful uses of atomic energy are only incidental to this discussion of the controls that must be developed through international cooperation and collaboration. Here are the chief conclusions: (1) The present time is peculiarly inappropriate to launch any plan within the UN framework; (2) the wisest course, under the circumstances would be to suspend all work on atomic bomb control until the UN can establish confidence among nations; (3) for the present the question will be safer in the hands of the U. S. than of the UN; (4) in the meantime, as a token of good intention, there should be a ban on the use of atomic weapons in war but, on the analogy of gas and bacteriological warfare, national research should not be forbidden.

Chemical Chromatics

THE CHEMISTRY AND PHYSICS OF ORGANIC PIGMENTS. *By Lyde S. Pratt. John Wiley & Sons, New York. 359 pages, $6.*

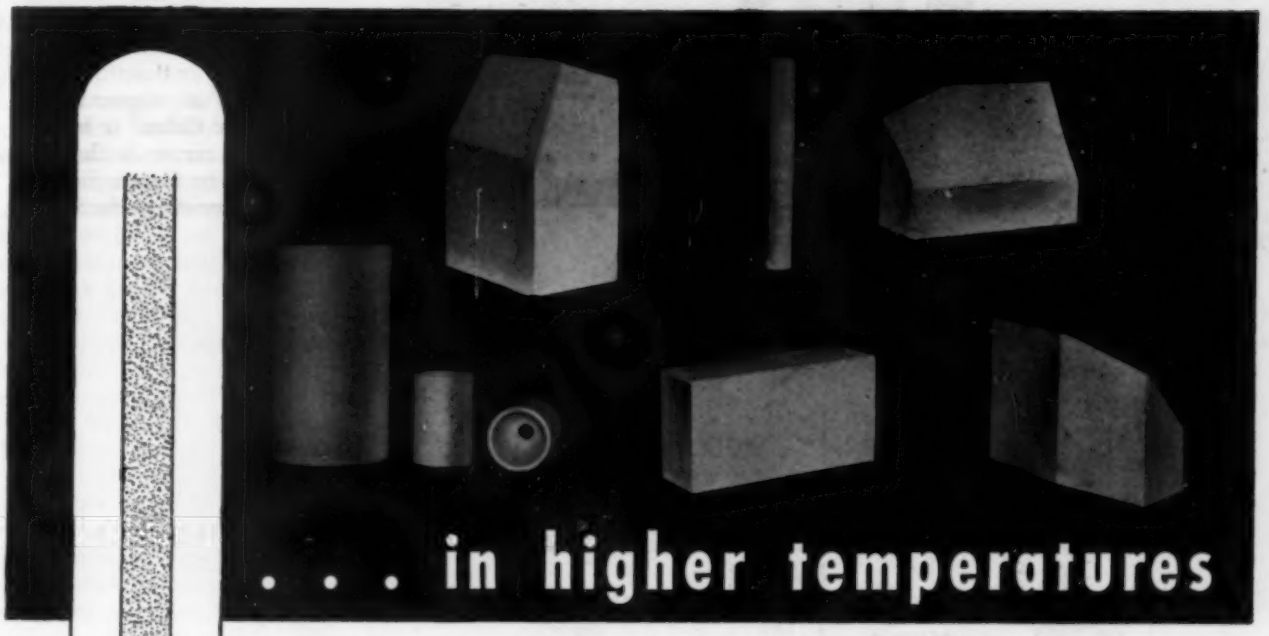
Reviewed by L. W. Ryan

THIS welcome contribution fills a void of long duration in the technical literature. In no more words than are necessary, a comprehensive picture of this important subject matter is presented. The arrangement is orderly and logical.

After a brief introduction, there appears a short history which includes a chart showing the chronological development of organic dyestuffs and pigments from Perkins' epoch-making preparation of the first synthetic dyestuff to the present. In the chapter on "Color and Chemical Structure," the various observations on the effect of chemical structure on color, from that of Graebe and Liebermann on the correlation between unsaturation and color to the recent conception of the effect of resonance, are presented. A dyestuff is always the same in color characteristics if the chemical composition is the same. Organic pigments, on the other hand, may have the same chemical composition and be vastly different in color characteristics, due to particle size and other physical differences. The chapter on "Color and Physical Structure" discusses adequately, in the light of present knowledge, the important physical properties and their effects on color, a sphere in which much remains to be learned.

A chapter on general raw materials is followed by an important one on "Intermediates," in which structural formulas are included in equations for their preparation. This chapter gives

The shape of things to come . . .



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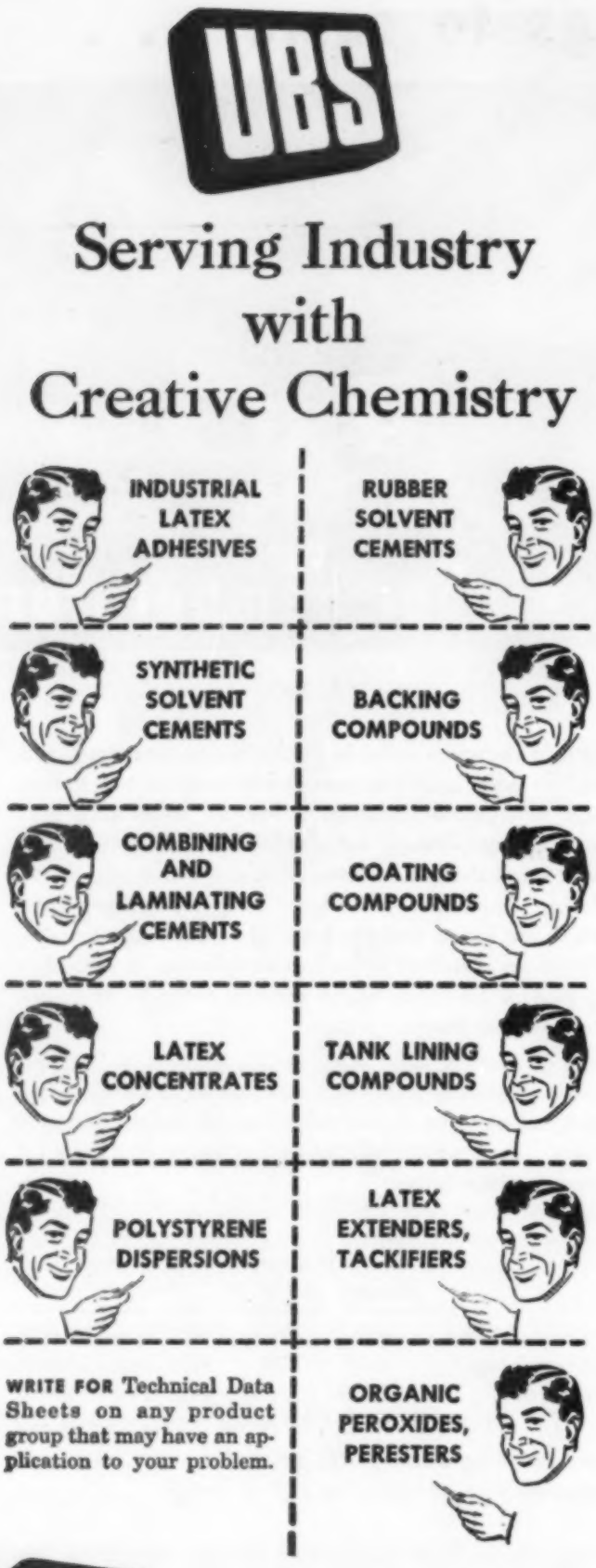


a detailed discussion of the intermediates and how they are formed. A chart illustrates the derivations from the basic raw materials—benzene, aniline, toluene, xylene, anthracene, naphthalene and anthraquinone. A chapter on "Pigments from Natural Organic Colors" is followed by the longest chapter in the book—that on "Synthetic Organic Pigments." Again, the chemistry of the formation of the pigments is illustrated by equations in which structural formulas are given.

Chapters on testing and identification present briefly the most modern methods. Testing equipment is described and, in many cases, illustrated by diagrams and photographs. A table near the end of the book lists the various organic pigment types and gives their properties.

Although there is some discussion of manufacturing procedures, the author has omitted detailed instructions for the preparations of the pigments. The methods, except for disclosures in patents, are trade secrets and vary considerably in different manufacturing plants. As in the case of other chemical processes, methods used today are obsolete tomorrow. A description of plant apparatus is outside the scope of the subject. The general chemistry of the manufacturing processes is given in sufficient detail.

The bibliography contains the important publications on the subject and the inclusion of references in the text is a desirable feature.

The book was written by one of the few recognized authorities on the subject and should be in the hands of everyone concerned with the manufacture or use of synthetic organic pigments. The author has been very successful in reducing an extensive and complex subject to a concise and clear presentation which constitutes an important ready reference.

Fireworks

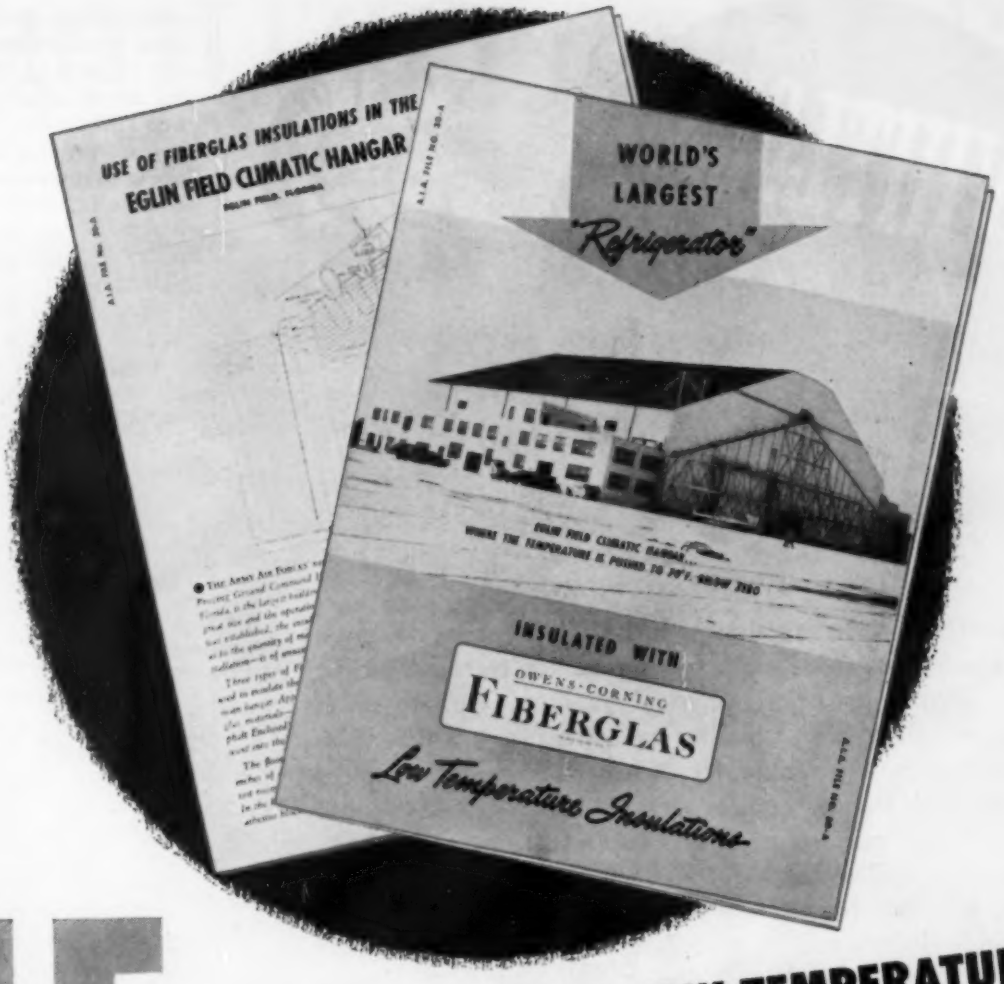
PYROTECHNICS. *Second Edition, By George W. Weingart. Chemical Publishing Co., Brooklyn, 244 pages. $7.*

Reviewed by Jules Bebie

As stated in the review of the first edition this book is valuable to makers of fireworks and as a record of authentic information on this specialized branch of chemical technology.

According to the preface "the revised and enlarged edition brings up to date the data on an industry which is becoming increasingly important."

The first edition has no index. Of the 24 additional pages in the second edition, ten are taken up by an index. The 14 pages of new material consists mostly of references to incendiary bombs, smoke grenades, rocket bombs,



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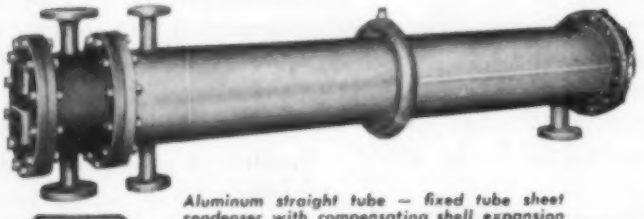

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and formulas for colored smokes developed by the Chemical Warfare Service. There is little new information on the art of making fireworks. Since the first edition was published in 1943 it is of course not surprising that during the war period not much attention was being paid to the advance of making fireworks as pleasure giving devices, to which this book is primarily devoted.

There is an addition to the second edition deserving honorable mention, the inclusion of four full page colored plates showing the beautiful effect of some outstanding fireworks, such as Willow Tree Shell, Liquid Fire Rocket, Comet and Aluminum Shell.

More Romance

THE CHEMISTRY AND TECHNOLOGY OF WAXES. *By Albin H. Warth. Reinhold Publishing Corp., New York. 519 pages. $10.*

Reviewed by C. L. Mantell

THE author is the chemical director of the Crown Cork and Seal Co. at Baltimore, Md. The volume is an exhaustive treatise dealing first with the chemical components of waxes in a more complete manner than that of Lewkowitsch, followed by a discussion of the different varieties of waxes, including the natural waxes, the fossil and earth waxes, the petroleum waxes, the synthetic materials, the emulsifiable waxes, waxy acids and metallic soaps, the technical or analytical tests and determinations for the constants of waxes, followed by a 130-page chapter on uses in industry. Detail is everywhere evident in the book, as illustrated by waxes from "the prettiest bee in the world" or "the blackest bee" or waxes from "stingless bees." In discussions of processing, the chemical phases are well treated but there is little mention of equipment, type or specific character.

One is intrigued with melissyl melissate and one almost feels it should have a southern accent, or zoomaryl alcohol without toxic effect, or wax constituents of plant lice, or mutton bird oil, the oil being found in the bird's stomach. Even fire menaces in the California forests are shrubs which yield snowblush wax. Detailed discussions of waxes from roots, rhizomes, and berries are illustrated by mistletoe berry wax and cranberry wax. Fruits such as apples yield wax, and shortly after its discussion there is one on opium wax. Waxes from flowers such as roses, violets, and jasmine add a distinctly scented touch to the discussion.

The reviewer finds a minor disagreement in the discussion of waxes from gum resins in that the author

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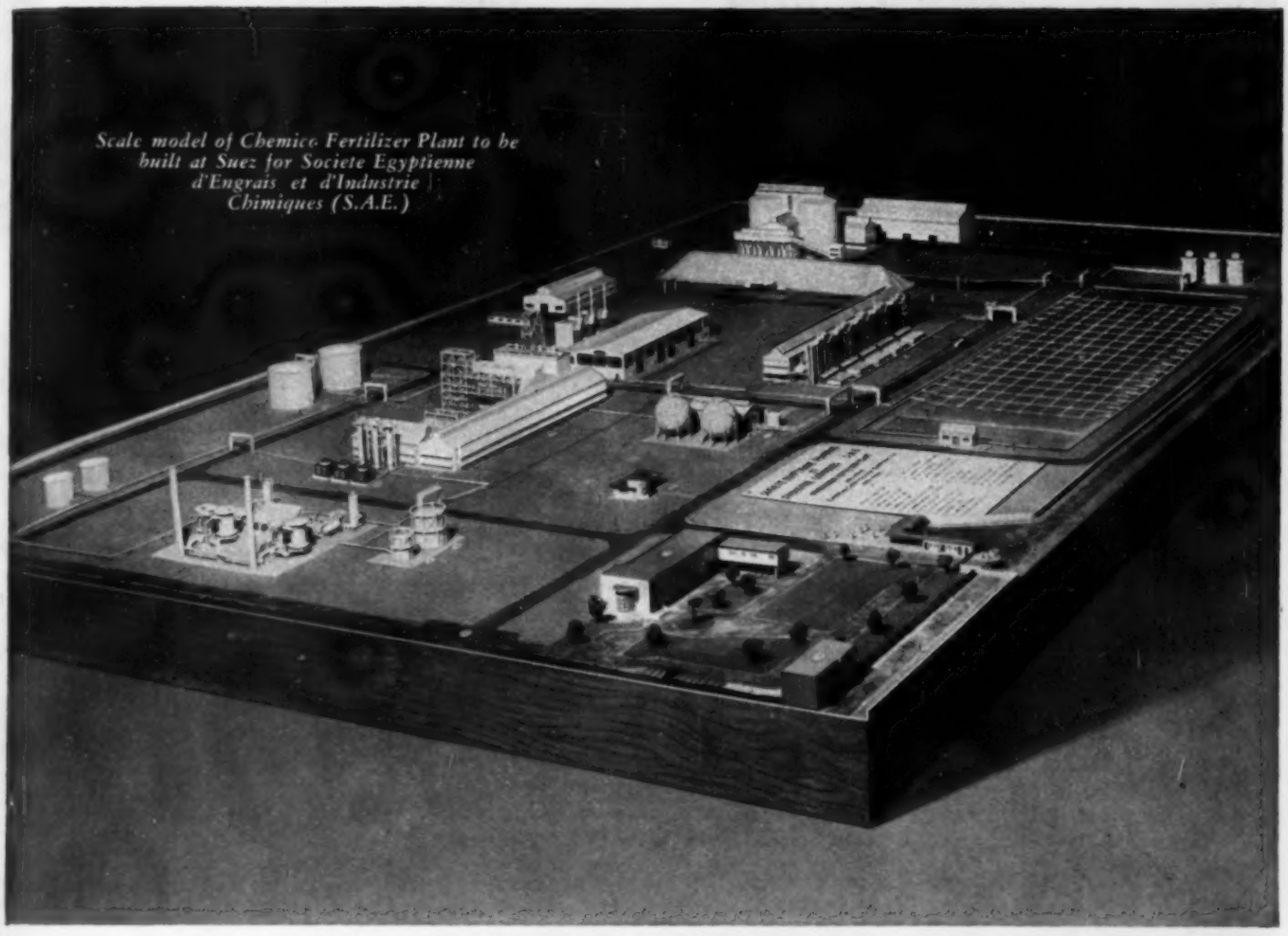

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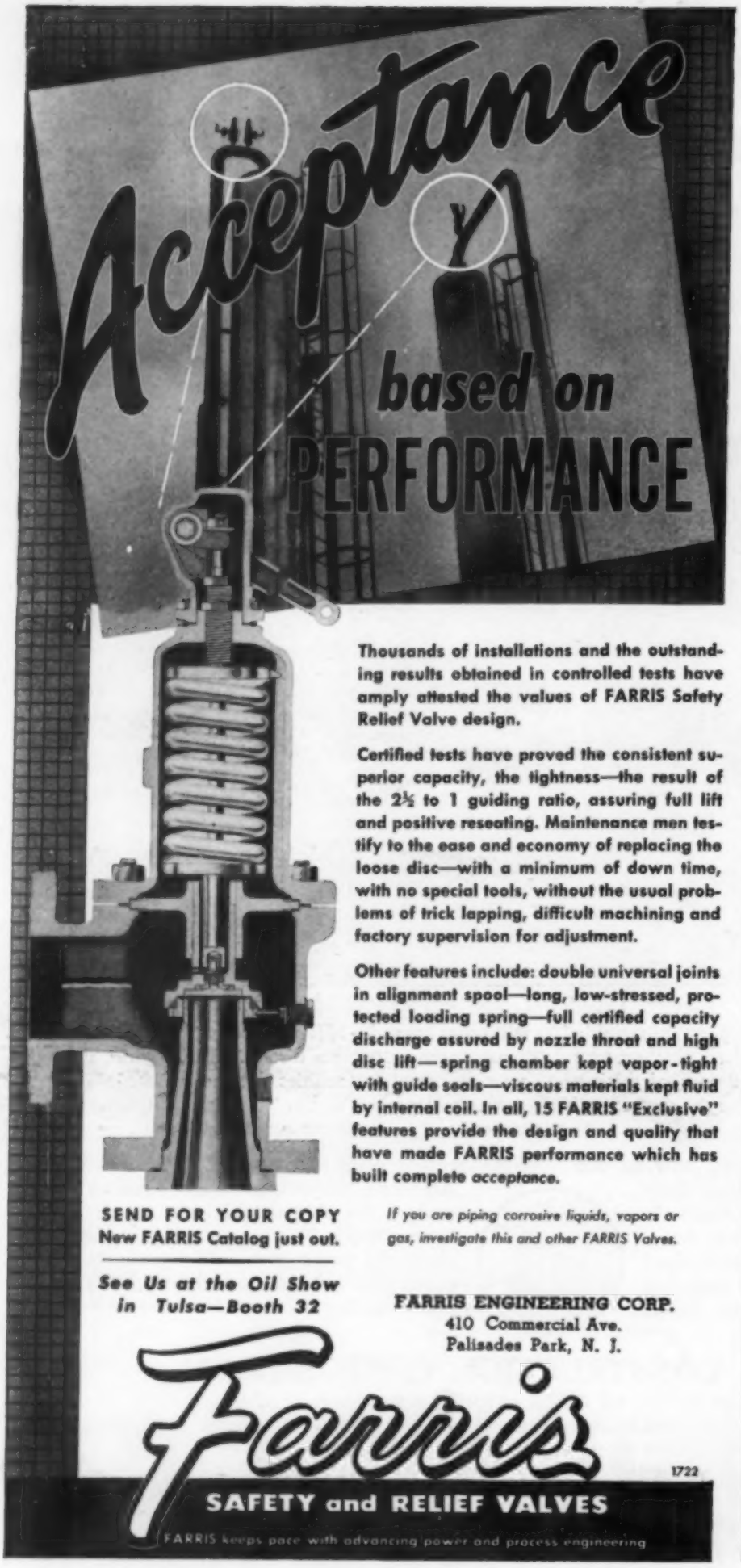

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classifies damar wax as a wax, while it is actually a resene, and such a classification should cause him to include waxes from materials like batu and the related semi-fossil resinous materials. These are perhaps a little more important commercially than the human tubercle bacillus wax discussed on the next page. In the discussion of petroleum waxes there is some indication of "cataloguing" while one might wish for a greater discussion of the intricate chemistry. The difficult problem of discussion of the synthetic waxes appears to be well handled, while the chapter on chemical constants will be welcomed as a reference source by workers in the field. It is in the discussion of wax technology with its many so-called trade secrets and with its art at times ahead of its science that the author will probably find some disagreement on the part of his readers.

The author tries to define wax which was derived from the Anglo-Saxon weax, the natural material of the honeycomb of the bee, and finally says that waxes are materials that have waxy physical characteristics and embrace a wide variety of chemically different materials. Considering the complexity of the job, the author has brought forth a comprehensive detailed addition to the literature which will be welcomed by those interested in this field. A difficult, exhaustive, and time-consuming job has been very well done and has resulted in a very readable and informative book.

The Why of the What

SURFACE CHEMISTRY FOR INDUSTRIAL RESEARCH. *By J. J. Bikerman. Academic Press, Inc. 464 pages. $8.*

Reviewed by Victor K. LaMer

"THIS volume is an exposition; adapted to industrial research of the fundamentals of surface science. Compared with textbooks on 'pure' surface chemistry, it contains less theory, and the theory presented is of the least hypothetical kind. It is different also from some books on applied chemistry of surfaces or colloids in that it does not set out to teach the procedures of any industry. It is written for people who know what is being done in their plant but want to know why it is done in a certain way and whether it can be done better. For this they may turn to fundamental knowledge, that is, to books such as the present one."

This quotation from the author's preface represents an accurate appraisal of this book. The author has not only succeeded in the objectives stated but he has also prepared a volume that will be useful as a text in courses in colloid science. The mathematics employed is simple but fundamental.

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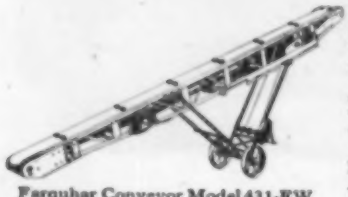

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The book abounds in well chosen figures, illustrating tables and concrete examples. A noteworthy feature is the frequent references to recent Russian literature. The book is well organized, well documented and very well indexed. It can be heartily commended for the purposes for which it is intended.

Petroleum Economics

A NATIONAL POLICY FOR THE OIL INDUSTRY. *By Eugene V. Rostow. Yale University Press, New Haven, Conn. 173 pages. $2.50.*

Reviewed by H. C. Parmelee

WHAT should be the national policy of the United States toward the great industries that characterize its economy? One attempt to find the right answer is being made at Yale University, where an interdepartmental program of research in national policy has been organized by members of the departments of economics and political science, and the school of law. The present book embodies one of these studies in national policy, relating to the petroleum industry. Being technically legal and economic in its analysis of the industry, the study is of primary value to lawyers and economists in the industry itself and in the legislative and judicial branches of the government. But because the objective of the research is the social and political results of industrial organization, the study will interest all who are concerned with the security and welfare of the nation and the individual.

In the judgment of the author the oil industry is still monopolistic in its organization. He believes that a more competitive form is socially and economically desirable. And he rejects the idea that reorganization in the interest of competition would necessitate giving up the economies and technological advantages of large-scale operation. Indeed, he contends that it should result in the elimination of wastes associated with excessive size.

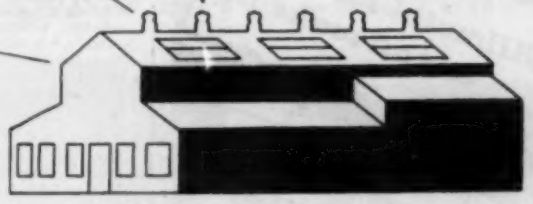
Reorganization of the oil industry should start with production control. Rejecting the rule of capture and methods of prorationing, the author proposes compulsory operation of oil fields as units of production under federal statute. This should be followed by division of the major companies into their four separate functions of production, refining, transportation, and distribution. Adoption of these and other measures would mean corollary changes in international policy.

Only the merest outline of this study and its conclusions can be given in this review. The development of the thesis calls for careful reading of the book.

1. Construction delays are retarding industrial expansion

2. Construction costs are taking bigger capital outlays

3. Process changes are making "heavy" building obsolete



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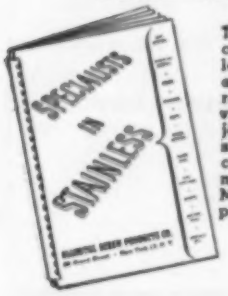

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Analysis of General Agreement on Tariffs and Trade. Department of State Publication 2983. Price 50 cents. Summarizes commodity changes in tariffs of agreements signed at Geneva, October 30, 1947.

Cement, 1915-1947. Department of Commerce, Construction Division. Processed. Includes data on production, shipments, stocks, exports, and prices.

Forecasts of the Populations of the United States, 1945-1975. Bureau of the Census. Price 45 cents. A basic guide to future market possibilities.

Federal Specifications Index. Bureau of Federal Supply, Federal Standard Stock Catalog, Section IV, Part 1. Price 35 cents. Lists by title and number general government specifications, but does not include those used by single departments like military agencies, nor include temporary or preliminary specifications not yet approved for general government use.

Copper Industry. Report of Federal Trade Commission. In two parts: Part 1, Copper Industry of the United States and International Copper Cartels; Part 2, Concentration and Control by the Three Dominant Companies. Sold as a pair for $1.25.

Publications of National Museum. List and index of United States National Museum for the period 1875-1946 inclusive, including some scientific items of industrial significance. Price $1.

Vitamin and Mineral Content of Certain Foods as Affected by Home Preparation. By Elizabeth M. Hewston, et al. Department of Agriculture, Miscellaneous Publication No. 628. Price 30 cents. Valuable as market guide for those selling feeds which are byproducts of process industry and those interested in vitamin and mineral food ingredients.

Animal Units of Livestock Fed Annually, 1919-20 to 1946-47. By R. D. Jennings, Bureau of Agriculture Economics, F. M. 64. Processed. Indicates magnitude and trend in animal-feed markets.

Clean Air (Removal of Dusts). Division of Labor Standards, Controlling Chemical Hazards Series No. 7. Price 10 cents. Nontechnical. Primarily for employees.

Hours of Work and Output. Bureau of Labor Statistics, Bulletin No. 917. Price 35 cents. A general summary of productivity in different divisions of industry as affected by the length of the work week. General section followed by 78 case studies in a few of which process industries are involved.

Labor Requirements to Produce Home Insulation. Bureau of Labor Statistics, Bulletin No. 919. Price 10 cents. Factory labor productivity study.

Report of the Administrator of Agricultural Research, 1947. Price 60 cents. Resume of scientific and engineering projects under way in the various technical bureaus of the Department of Agriculture, including Regional Laboratories.

Oil Crops in American Farming. By Peter L. Hansen and Ronald L. Migheil. Department of Agriculture, Technical

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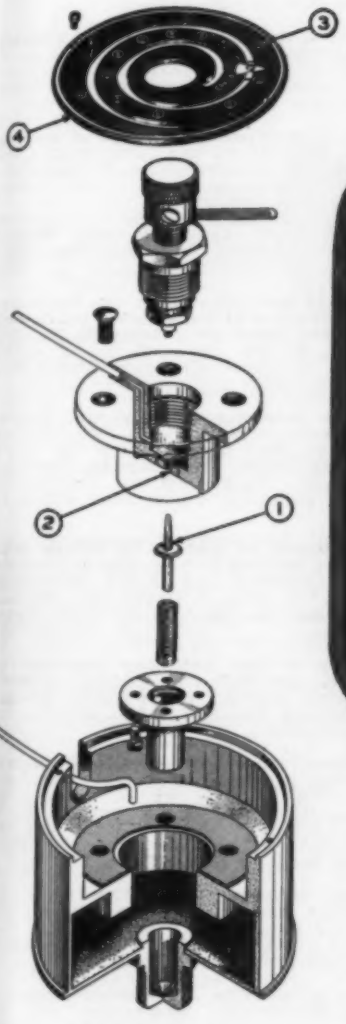

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4. Spiral scale permits nearly 2 full turns. Readings at smaller reset rates have greater spacings

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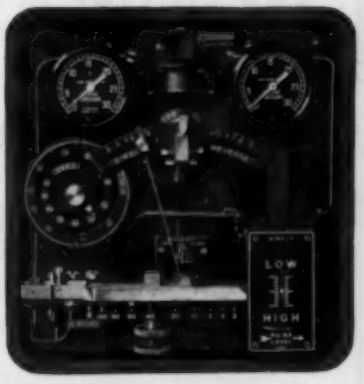

Model 12610 Proportional-Reset Controller

Model 12610 Controller

Masoneilan proportional-reset level controllers have the entire reset mechanism *inside* the instrument case.

Reset is thus accessible, compact and protected.

The 12000 Series controllers with pneumatic reset are *package* units, complete and standard with the reset bellows and resistance unit integral, built-in. Masoneilan duplex level controllers and controller-transmitters also have this reset.

There are no external connections or adjustments to make. There is no external piping. And since the reset is an integral part of the controller and not an external appliance, the reset mechanism is always accurately calibrated, with graduations on a ten-inch scale proportional to actual reset rates.

When to Specify Reset . . .

1. When you want to get maximum vessel surge capacity at all times and in the presence of large and sustained load changes.
2. When smooth, uniform, controlled flows are essential to process operation.
3. When the level controller pneumatically sets the set point of a flow controller, or of several flow controllers in split-stream operation.

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Preparation Characteristics of Maryland Coals. By W. L. Crents and Thomas Fraser. Bureau of Mines, Technical Paper 701. Price 15 cents.

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Secondary Recovery of Oil by Water-Flooding in Fields of North Texas. By Robert K. Guthrie, et al. Bureau of Mines, Report of Investigations R. I. 4250. Mimeographed. Supplement to R. I. 3906, History of Water-Flooding of Oil Sands in North Texas.

Sponge Iron in Japan. By Theo. L. Johnston. Bureau of Mines, Information Circular I. C. 7440. Mimeographed. Describes plant methods used in manufacture and scope of industry.

Effect of Sheaths on Gaseous Products from Permissible Explosives. II. By E. J. Murphy. Bureau of Mines, Report of Investigations R. I. 4220. Mimeographed. Deals primarily with mine usage, but is also significant as to types of explosives made.

An Investigation of a Laboratory Test for Determination of the Free-Swelling Index of Coal. By W. A. Selvig and W. H. Ode. Bureau of Mines, Report of Investigations R. I. 4238. Mimeographed. A revision of R. I. 3989.

Consumption of Slab Zinc in the United States by Industries, Grades, and Geographic Divisions, 1940-45, Including a Summary of Consumption Since 1900. By Alfred L. Ransome. Bureau of Mines, Information Circular I. C. 7450. Mimeographed.

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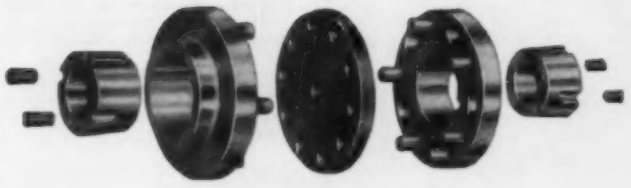

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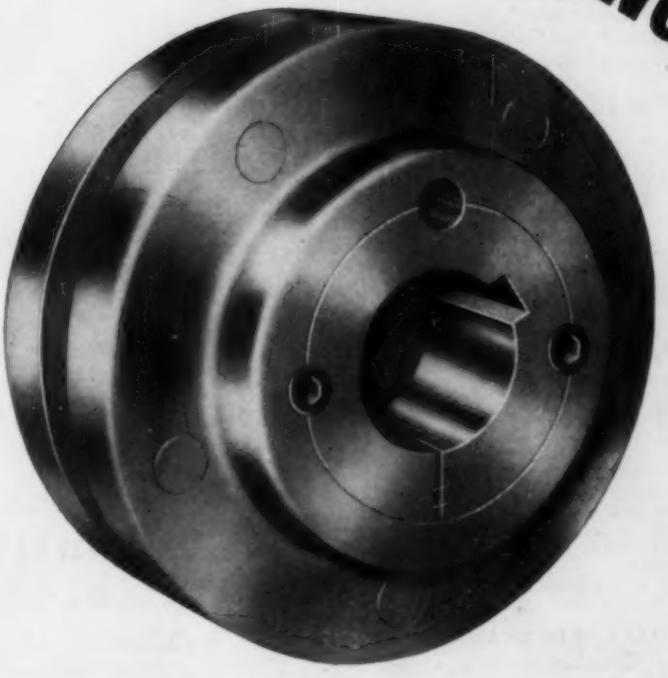

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(*Continued on page* 170)

couplings made by this company. Includes dimensions and list prices for various models.

112. Lead Products. Knapp Mills, Inc., New York, N. Y.—12-page booklet describing current developments and improvements in the employment of lead-lined products, chemical apparatus and lead construction in general.

113. Solvents. Dubois Co., Cincinnati, Ohio—12-page booklet giving information on flash point, boiling ranges, chemical composition, toxicity, for solvents most frequently used in metal cleaning. Use of this company's emulsifiable oil detergent Actusol for use with solvents is discussed.

114. Protective Coatings. Bee Chemical Co., Chicago, Ill. — 11-page loose-leaf bulletin containing technical data on Logoquant, a surface treatment for polystyrene plastic. Properties and applications are discussed.

115. Power Transmission. D. O. James Gear Mfg. Co., Chicago, Ill.—Catalog 46-47, a plastic-bound 120-page catalog containing engineering data and prices on motorized geared speed reducers.

116. Bearings. New Departure Div., General Motors Corp., Bristol, Conn.—The fourth in a series of books for engineers issued by this company entitled "Bearing Load Computation." Includes an explanation of the process of computing bearing reaction, using the three conditions of equilibrium, followed by typical examples numerically worked out for various types and arrangements of gears.

117. Nickel-Alloy Steels. International Nickel Co., Inc., New York, N. Y.—48-page booklet dealing with the properties and uses of heat-treated nickel alloy steels. Contains a large number of performance curves showing the tensile strength and yield point of different alloys in different sizes tempered under various conditions.

118. Fiberglas Reinforced Plastic. Owens-Corning Fiberglas Corp., Toledo, Ohio—36-page booklet containing information on the properties of Fiberglas reinforced plastics, their range of applications, economics of their manufacture and use, and manufacturing methods. Includes tables of properties of Fiberglas cloth and mats employed in this work.

119. Waterproofing Compound. Sika Chemical Corp., Passaic, N. J.—4-page leaflet illustrating and describing the use of quick-setting mortars for sealing heat against pressure. Detailed applications are illustrated.

120. Strainers. Armstrong Machine Works, Three Rivers, Mich.—Bulletin 184 is a 2-page leaflet describing the Y-type strainer for steam, gas, air, water and oil lines.

121. Bearings. Rollway Bearings Co., Inc., Syracuse, N. Y.—Catalog 817, 16-page catalog illustrating and describing the new Tru-Rol bearing made by this company. Contains dimensions and load rating tables for this line of steel cage type cylinder for roller bearings.

122. Metallurgical Specialties. Exomet, Inc., Conneaut, Ohio—12-page bulletin describing the metallurgical products made by this company. Savings involved

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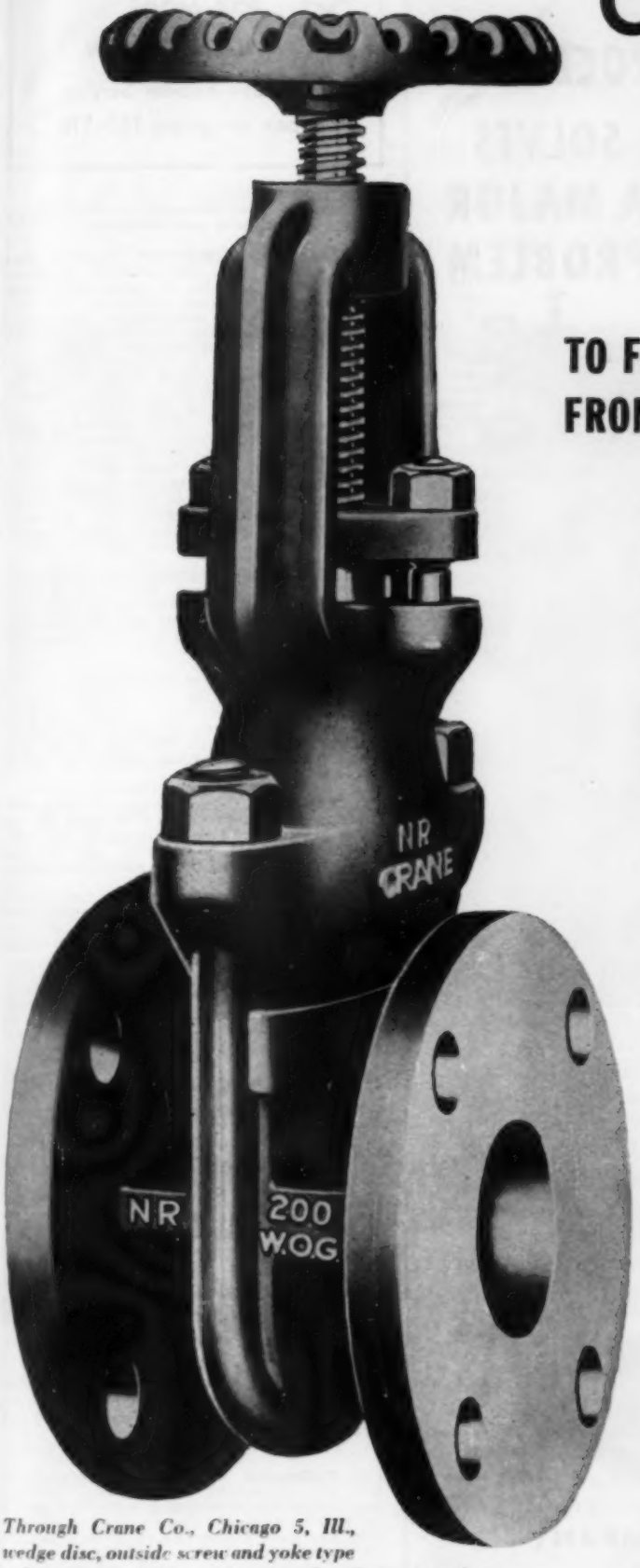

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by use of the company's products in foundry processes are discussed.

123. Electrical Equipment. Electric Machinery Mfg. Co., Minneapolis, Minn.—Bulletin 192 contains 8 pages describing the construction and operation and application of this company's "Hi-Fuse" combination starter for high voltage induction and synchronous motors.

124. Water Heater. Sarco Co., Inc., New York, N. Y.—Catalog No. 900, a 2-page leaflet featuring the Type SWV steam and water mixer for heating water. Details of construction are illustrated in a cutaway view.

125. Welding Products. American Manganese Steel Div. of American Brake Shoe Co., Chicago Heights, Ill.—Bulletin 1047-W describes welding products for use in equipment maintenance.

126. Electrical Switches. MicroSwitch, Freeport, Ill.—Vol. 1, No. 1 of a new publication entitled "Micro Switch", a 4-page folder containing suggestions for using Micro Switches in industrial plants.

127. Gases. The Matheson Co., Inc., East Rutherford, N. J.—6-page folder containing a price list of over 50 rare and common gases. This bulletin illustrates and describes the automatic and non-automatic controls for use with different gases.

128. Reagents. Meyer Supply Company, Inc., Brooklyn, N. Y.—A 4-page folder describing the direct titration of sulphates with barium chloride solution using tetrahydroxyquinone as an indicator.

129. Signal Equipment. Leslie Co., Lyndhurst, N. J.—Bulletin 466-A contains engineering operating and maintenance data on the whistles and signals made by this company.

130. Electrical Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—16-page bulletin No. 11B6935 illustrates and describes the MCS unit substation made by this company.

131. Packaging Equipment, Triangle Packaging Machinery Co., Chicago, Ill.—6-page bulletin describes automatic and semi-automatic vibratory feed weighers for filling dry products into packages. Typical operations are described and illustrated.

132. Tanks. Metal Products Corp., Weehawken, N. J.—4-page leaflet cataloging the various metal tanks, pails and other similar equipment for use in chemical plants.

133. Screens. Robbins Conveyor Div., Hewitt-Robbins, Inc., Passaic, N. J.—4-page booklet No. 122-A illustrates and describes the screens made by this company.

134. Metallizing. Metalweld, Inc., Philadelphia, Pa.—Leaflet describes maintenance of worn machinery and equipment by use of metallizing techniques.
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135. Hydraulic Cylinders. Hydre-Line Mfg. Co., Rockford, Ill.—28-page catalog describing the hydraulic cylinders made by this company. Features of construction are shown and tables of dimensions of the various models are given.

136. Safety. Allegheny-Ludlum Steel Corp., Pittsburgh, Pa.—20-page booklet on plant safety practices used for the purpose of making plant employees more safety conscious.

137. Flexible Hose. American Ventilating Hose Co., New York, N. Y.—6-page leaflet illustrating the uses of flexible hose in ventilating and exhaust systems. Also included is a price list for the various types of hose.

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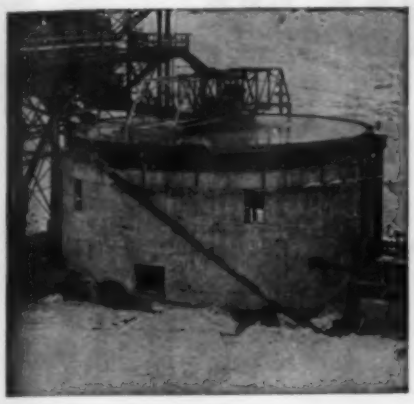

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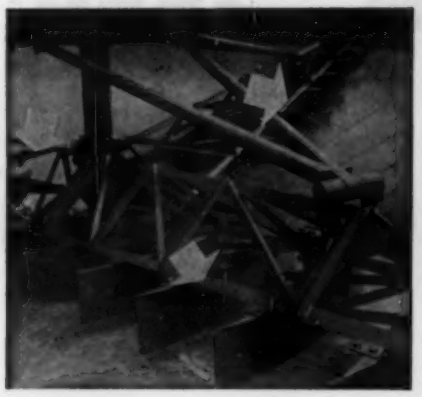
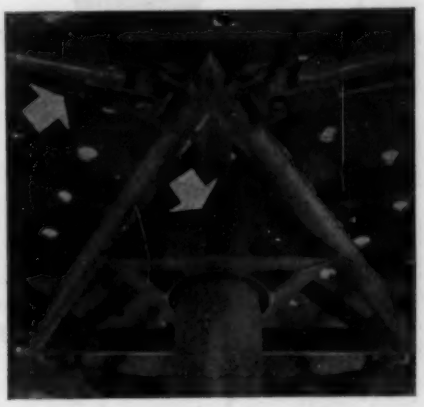


Maximum strength and rigidity are accomplished through the use of triangular construction. For instance, rake blades are mounted on *three* rotating arms, driven by pivoted drive rods.



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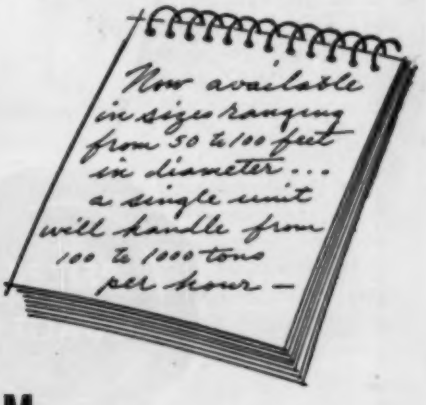

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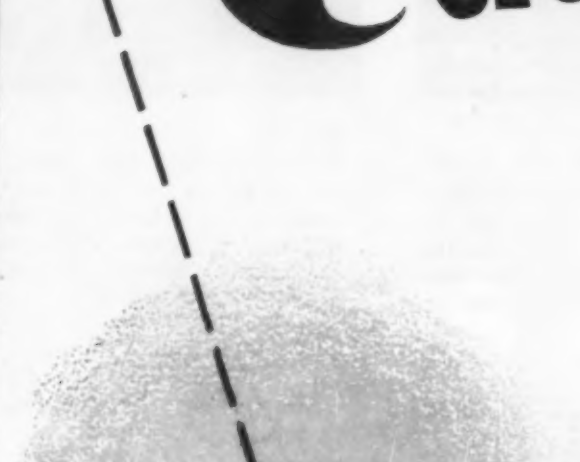

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CHEMICAL ECONOMICS

Richard F. Warren, ASSISTANT EDITOR

SECOND QUARTER STARTED WITH CHEMICAL CONSUMPTION AT HIGH LEVELS

ALTHOUGH the coal strike had an adverse effect on April production of chemicals, there was considerable reason for an optimistic outlook for the second quarter. Floods in early April also created transportation problems in the Ohio River system and cut into production of chemicals in that area. Complete data are not yet available, but March consumption of many chemicals was high. *Chemical Engineering* index of industrial consumption of chemicals dropped to 219.20 in February as a result of the short working month and hard winter. However, this level is well above the February 1947 level of 208.61.

Many producers are looking beyond the present labor difficulties to plan for increased production as new capacities relieve the present caustic soda and chlorine shortage. Plants like the new Diamond Alkali unit, which will start operation in Houston this summer, should put a dent in the current deficit of these materials. Carbide and Carbon, Du Pont and Shell are completing large expansion plans for organic chemicals in Texas and Monsanto's rebuilt Texas City unit is well on the way to completion. However, some chemicals have no such immediate relief in sight. An example is cresylic acid. This chemical is in extremely short supply along with ortho-meta-para cresol and meta-para cresol. The plastics industry wants more.

U. S. Steel is seriously considering entering the business of refining crude coal chemicals produced at its coke ovens. However, no decision has been reached. This company has sold its coal chemicals in the crude form in the past. There is serious opposition in the company to any extensive byproduct refining expansion program in view of its present large steel expansion program. While not generally considered a chemical producer, it produces about one-third of the country's total output of ammonium sulphate, benzene and tar. Among the other chemicals it makes are naphthalene and tar acids. Coal chemical producers and consumers are watching this situation with a great deal of interest since it may have considerable influence on the growth of this branch of the industry.

Coal chemical production received an added setback last month when the Newark, N. J., plant of Reilly Tar and Chemical Corp. was seriously damaged by fire.

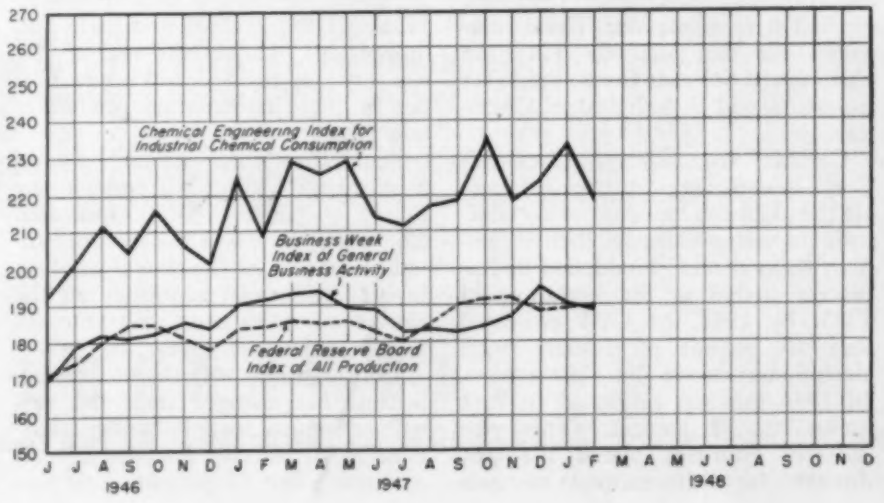
Decision of the Cuban government to set aside 40 million gallons of blackstrap molasses to make alcohol for fuel will have a serious effect on this country's alcohol industry. The material is already in short supply and this will aggravate the situation. Cuban alcohol stocks have been frozen and 1,367,000 gal. have been allocated for production of fuel. United States production of pure undenatured alcohol for the first eighth months of the current fiscal year was 218 million gallons compared with 154 million gallons produced for corresponding months of the last fiscal year. This fiscal year, over 211 million gallons have been withdrawn tax-free. In addition to these withdrawals, 26 million were withdrawn tax-paid during the eight-month period.

Natural rubber consumption in the first quarter was high. Some consumers have remarked on the improved quality of rubber reaching their plants in recent months. Natural rubber consumption dropped to 50,927 long tons in February from 58,174 long tons in January. This was still almost 25 percent above the February 1947 figure. Synthetic rubber production was down in February to 35,158 long tons, or almost 35 percent below the same month in 1947. Reclaimed rubber consumption also fell off 14 percent for the corresponding period. This decline was largely due to the short work month.

Consumption of plastics and synthetic resins also reflected the short month. Nitrocellulose plastics was the only branch that registered gains in February. Molding of all types was well below January totals.

***Chemical Engineering* Index**
Industrial Consumption of Chemicals
1935 = 100

	Jan. (Revised)	Feb.
Fertilizers	55.70	53.50
Pulp and paper	23.95	21.60
Petroleum refining	21.85	20.42
Glass	19.28	17.92
Paint and varnish	24.48	21.50
Iron and steel	13.62	12.78
Rayon	26.38	23.82
Textiles	11.95	13.10
Coal products	10.72	10.01
Leather	4.76	5.01
Explosives	7.38	7.15
Rubber	5.88	5.09
Plastics	8.53	7.75
Index	234.48	219.20



Shell is completing a new secondary butyl alcohol unit at this Houston plant. It will be operating in June.

Butyl Alcohols

Who Makes Them

Company	Plant Location	Process
Normal, primary		
Carbide and Carbon Chemical Corp.	South Charleston, W. Va. Texas City, Tex.	Ethyl alcohol
Commercial Solvents Corp.	Peoria, Ill.	Fermentation
Publicker Industries, Inc.	Philadelphia, Pa.	Fermentation
U. S. Industrial Chemicals, Inc.	Baltimore, Md.	Fermentation
Secondary		
Shell Chemical Corp.	Dominguez, Calif. Martinez, Calif. Houston, Texas	Petroleum
Standard Oil Co. (New Jersey)	Bayway, N. J.	Petroleum
Isobutanol		
E. I. du Pont de Nemours and Co.	Belle, W. Va. Orange, Tex.	$CO+H_2$
Tertiary		
Shell Chemical Corp.	Martinez, Calif.	Petroleum

Consumption Pattern

Normal, Primary, Butyl Alcohol

(Percent)

	1944	Present
Chemical manufacturing	59.1	69
Lacquer solvents	15.3	15
Other uses	16.4	5
Export	9.2	16
Total	100.0	100

COMMODITY SURVEY

THIS group of butyl alcohols is widely used in many industries. Consuming demand is high and the production curve shows it. Primary normal butyl alcohol is produced in the largest quantities. Production of this alcohol grew from 49 million pounds in 1934 to 139 million pounds in 1947. Production of all other butyl alcohols is estimated to be slightly in excess of 100 million pounds per year at the present time.

While primary butyl alcohol business is good, some of the producers are faced with raw materials problems. This chemical is produced by two different processes. The first method is fermentation. Three companies use this method. They are Commercial Solvents Corp., Publicker Industries, and U. S. Industrial Chemicals.

Carbide and Carbon Chemicals Corp. manufactures it from ethanol, via the aldol condensation of acetaldehyde to crotonaldehyde, then to primary butyl alcohol. Production by this process started at the beginning of 1933. By 1942 the OPA estimated that 20 percent of primary butyl alcohol was made by this process. In 1944 this was estimated to have grown to 30 percent. This year industry estimates placed the production by this method at over 50 percent of the total production. The trend was spurred by war and postwar shortages of molasses and grain. In fact molasses is the great enigma in the butyl alcohol picture.

During the war, butanol was so scarce that we used many raw materials to produce it. The Western Condensing Co. used cheese whey as a starting point.

Demand is still heavy and experts predict that the market will continue to grow. Proof of this optimism is seen in the large expansions in plant capacity recently completed by Carbide at Texas City.

Pricewise the situation shows the effect of rising material and processing costs. In 1931 it sold at 15¾ to 16¾c. per lb., in 1939 the price had dropped to 8½c. At the end of the war it was up to 18½c. and is now 17c. per lb. The fermentation product is now 32c.

From the "water stream" of proposed Synthol plants will come a new supply of butanol. U. S. Industrial Chemicals, Inc., will market this output. Estimates on the time it will take to get commercial quantities on the market vary from two to five years, although some may appear in 1949.

Consumption pattern of primary butanol has changed since the war, with chemical manufacturing taking close to 70 percent. Lacquer solvents consume about 15 percent. Last year we exported 22,178,000 lb., of the 139,000,000 lb. produced.

Secondary Butyl Alcohol

Secondary butyl alcohol producers are Shell Chemical Corp. and Standard Oil Co. (New Jersey). Shell has plants at Dominguez and Martinez, Calif., and is building another unit at Houston. This is expected to be operating in June. Standard produces its secondary butyl at Bayway, New Jersey. It is also expanding its facilities. This product is used to make methyl ethyl ketone and other secondary ketones as well as esters. It is also used as a solvent and thinner in lacquers.

Tertiary butyl is produced by Shell at Martinez as a petroleum byproduct and according to reliable trade sources Shell is producing ample quantities of this material.

Isobutyl alcohol is made by Du Pont at Belle, W. Va., and Orange, Tex., in conjunction with methanol synthesis. Its principle use is brake fluid, with a considerable part of the production consumed as a solvent and organic chemical intermediate. Celanese is producing a mixture of 85 percent isobutyl and 15 percent primary butyl alcohol.

The outlook for all butyl alcohols is heartening. Expansion programs now in progress or recently completed should ease the supply situation soon.

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Safety is assured with Lukenweld Jacketed Drier Rolls. Made of steel plate, their high strength permits steam pressures to be stepped up safely to 350 psi. and over.

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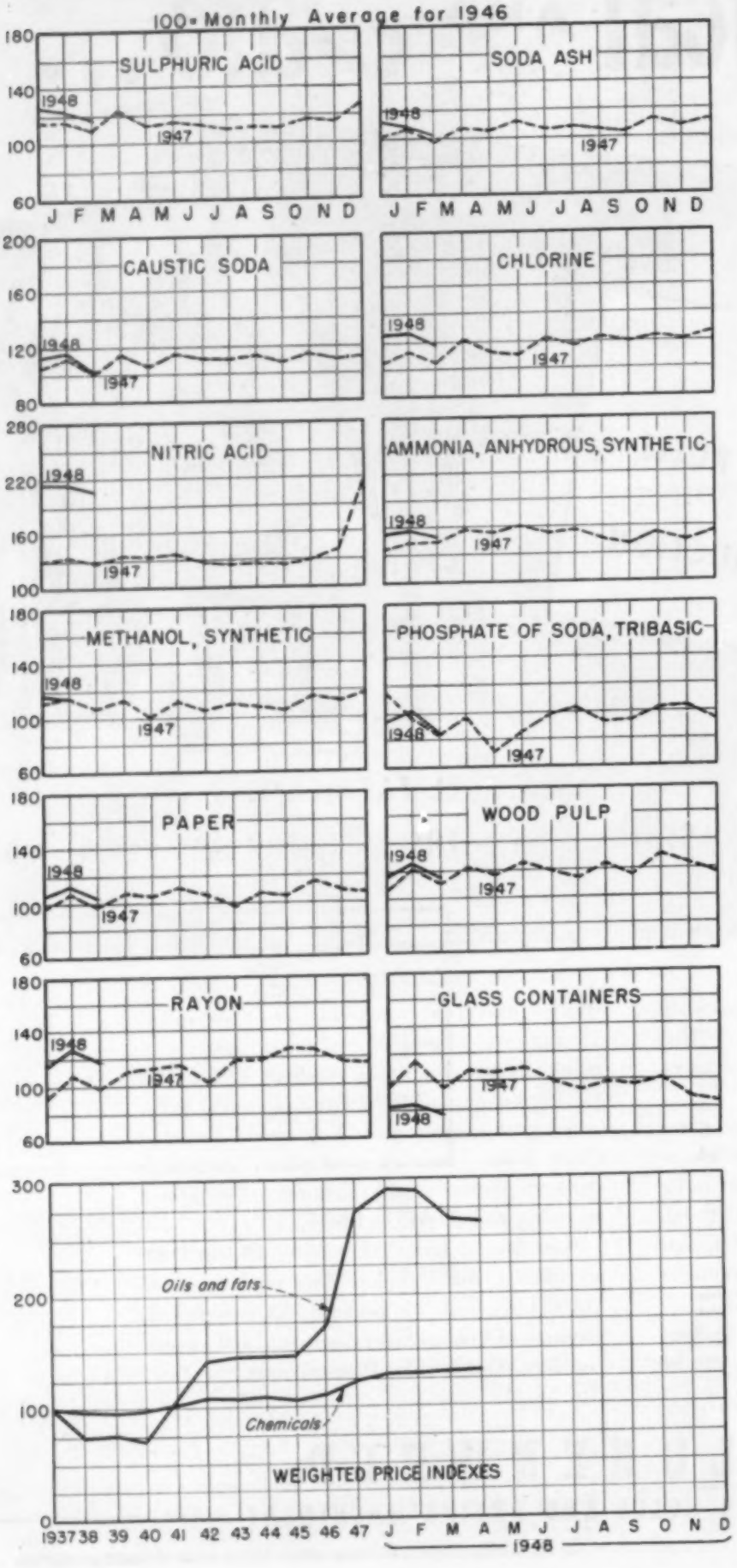
PRODUCTION, CONSUMPTION AND PRICE TRENDS



PRODUCTION of ammonia and ammonium nitrate fell behind demand in spite of record production levels reached in recent months. Methanol capacity may receive a setback as a result of the tight ammonia situation.

New formaldehyde capacity will come on stream late this year when the Spencer Chemical Co. completes its plant near Chicago. It recently began methanol production at another plant in Military, Kan.

Soda ash producers felt the pinch of the coal strike in April. Several were faced with extremely low fuel supplies as Lewis reached an agreement on the miners' pension plan. However, the full effects of the strike were not felt in the first quarter.

Rayon consumption in March was 90.8 million pounds. This was 19 percent above the corresponding month last year. Rayon stocks rose from 14.1-million pounds in February to 14.2-million pounds at the end of March. New capacity for viscose production is due this year. Childersburg, Ala., is the site of a filament yarn plant under construction for Beaunit Mills. The new unit has an annual capacity of 10 million pounds. United Rayon Corp., a new firm, is planning to build a viscose yarn and staple unit with a 12 million pound annual capacity.

First quarter production of wood pulp was well above the same quarter last year. Paper output for that period was down slightly from the first quarter of 1947, but remained above levels maintained in the last quarter of 1947. Glass container production in February fell off about 8 percent from the January output. Plate glass production was also down slightly in February.

Price Trends

Alcohol, tallow and turpentine were among items that dropped in price late in April. Chemicals registering gains included calcium carbide, salt cake and gylcerine. Both price indexes moved higher during April.

Chemical Engineering

WEIGHTED INDEXES OF PRICES

Base = 100 for 1937

	Chemicals	Oils & Fats
As of May 1..	131.11	289.53
Last Month ..	129.84	263.42
May 1947	123.54	272.16
May 1946	109.13	145.85

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United States Production of Certain Chemicals

February 1948, February 1947 and Two-Month Totals for 1948 and 1947

Chemical (Tons unless otherwise noted)	February 1948	February 1947	Total, Two Months 1948	Total, Two Months 1947
Ammonia, synthetic, anhydrous[1]	90,550	85,663	185,055	170,791
Ammonium nitrate	88,649	84,070	184,006	173,817
Ammonium sulphate, synthetic, technical (M lb.)	31,712	26,791	66,964	51,370
Calcium arsenate (M lb.)	2,433	1,843	4,436	3,268
Calcium carbide, commercial	55,606	45,411	113,097	106,986
Calcium phosphate:				
Monobasic (M lb.)	6,058	5,794	11,761	12,835
Dibasic (M lb.)	5,703	5,794	11,761	15,611
Carbon dioxide:				
Liquid and gas (M lb.)	17,374	14,019	33,658	31,022
Solid (M lb.)	42,030	35,839	82,771	78,986
Chlorine	116,143	101,717	230,462	211,366
Chrome green, (C.P.), (M lb.)	1,026	1,317	1,984	2,990
Chrome yellow and orange (C.P.) (M lb.)	3,605	3,286	7,681	6,994
Hydrochloric acid, 100 percent	33,940	33,966	75,029	69,110
Hydrogen (million cu. ft.)	2,119	1,564	4,321	3,315
Lead arsenate, acid and basic (M lb.)	3,697	3,691	6,926	8,814
Molybdate chrome orange (C.P.) (M lb.)	479	408	969	837
Nitric acid, 100 percent	100,546	62,193	204,380	126,331
Oxygen (million cu ft.)	1,258	1,010	2,529	2,111
Phosphoric acid, 50 percent	91,070	74,926	185,401	153,321
Soda ash:				
Ammonia soda process:				
Total wet and dry[2]	360,437	350,634	743,918	731,221
Finished light[3]	191,173	167,838	280,800	362,703
Finished dense	111,097	129,155	247,609	258,970
Natural[4]	23,232	18,612	45,621	37,316
Sodium bicarbonate, refined	14,171	15,329	27,361	30,814
Sodium bichromate and chromate	7,106	5,954	14,770	12,933
Sodium hydroxide:				
Electrolytic process:				
Liquid[5]	112,669	96,730	231,730	205,428
Solid	21,263	16,695	46,432	34,685
Lime soda process:				
Liquid[5]	61,024	60,056	124,741	124,727
Solid	20,243	18,395	41,217	39,811
Sodium phosphate:				
Monobasic	829	1,278	1,897	2,372
Dibasic	6,063	6,034	12,626	12,272
Tribasic	5,759	6,600	14,884	14,411
Meta	2,609	2,168	5,121	4,312
Tetra	5,103	3,892	10,052	8,002
Sodium silicate, anhydrous	44,090	35,884	81,619	75,870
Sodium sulphate:				
Anhydrous, refined	12,256	10,468	25,271	22,644
Glauber's salt[4]	15,621	16,433	34,078	33,771
Salt cake, crude, commercial[6]	48,528	46,775	100,427	95,712
Sulphuric acid:[6,7]				
Chamber process	274,047	279,531	550,781	573,843
Contact process, new	567,599	512,119	1,164,718	1,058,945
Zinc yellow, (zinc chromate) (C.P.)	392	283	700	.....

Data for this tabulation have been taken from "Facts for Industry" series issued by Bureau of the Census. Production figures represent primary production and do not include purchased or transferred materials. Quantities produced by government-owned arsenals, ordnance works, and certain plants operated for the government by private industry are not included. Chemicals manufactured by TVA, however, are included. All tons are 2,000 lb. Where no figures are given data are either confidential or not yet available. [1]Includes a small amount of aqua ammonia. [2]Total wet and dry production, including quantities diverted for manufacture of caustic soda and sodium bicarbonate, and quantities processed to finished light and finished dense. [3]Not including quantities converted to finished dense. [4]Data collected in cooperation with the Bureau of Mines. [5]Figures represent total production of liquid materials, including quantities evaporated to solid caustic and reported as such. [6]Includes oleum grades, excludes spent acid. [7]Data for sulphuric acid manufactured as a byproduct of smelting operations are included.

United States Production of Synthetic Organic Chemicals

January 1948 and January 1947

	January 1948	January 1947
Acetanilid	444,334	727,690
Acetic acid:		
Synthetic[1]	31,892,953	32,997,431
Recovered	142,756,264	121,412,431
Natural[1]	2,296,288	2,154,450
Acetic anhydride[2]	62,700,326	49,157,280
Acetone	36,944,596	31,721,810
Acetylsalicylic acid	979,411	925,455

(Continued on page 350)

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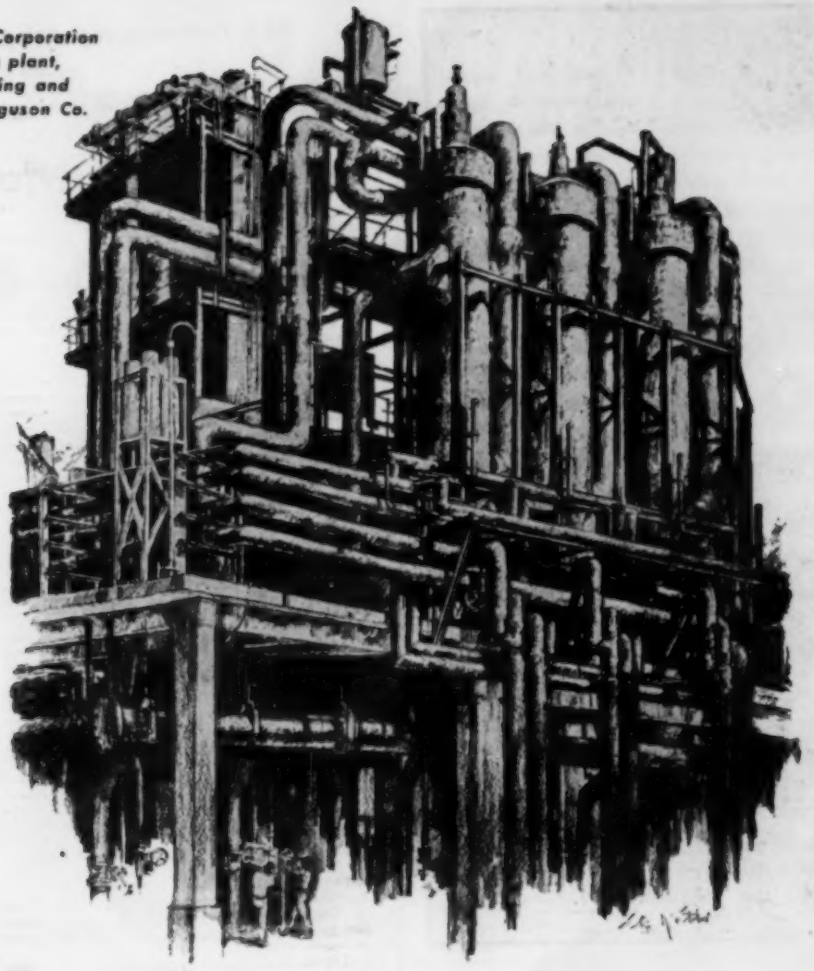

Liquefiers in Southern Alkali Corporation chlorine and caustic soda plant, Lake Charles, La. Engineering and construction by The H. K. Ferguson Co.

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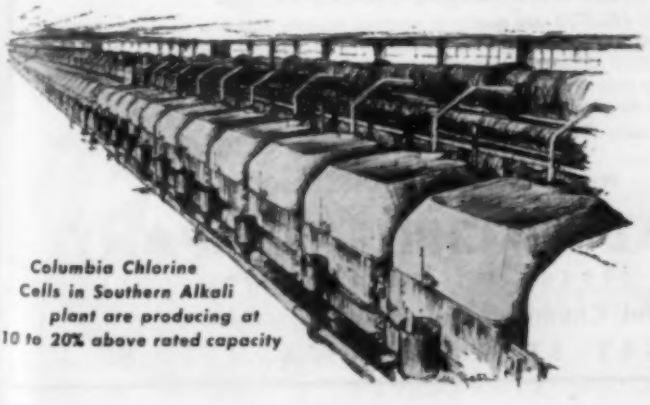

Columbia Chlorine Cells in Southern Alkali plant are producing at 10 to 20% above rated capacity

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OTHER ORGANIC CHEMICALS

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U. S. Production of Certain Organic Chemicals (Cont. from page 348)

	January 1948	January 1947
Aniline	9,488,617	8,772,510
5-Ethyl-5 phenylbarbituric acid and salts (phenobarbital)	61,772	39,172
Benzene:		
Motor grade:		
Tar distillers[4]	.....	686,277
Coke-oven operators[5]	1,210,717	2,172,956
All other grades:		
Tar distillers[4]	1,178,998	.....
Coke-oven operators[5]	12,842,769	12,631,983
Butyl alcohol, primary, normal	11,146,280	13,977,202
Carbon bisulphide	30,159,133	29,187,527
Carbon tetrachloride	18,638,275	15,765,452
Chlorobenzene, mono	28,608,266	25,352,334
Creosote oil:		
Tar distillers[4]	9,510,471	10,696,738
Coke-oven operators[5]	3,332,032	3,341,107
Cresols, meta-para[7]	582,803	386,411
Cresols, ortho-meta-para[7]	611,428	664,522
Cresylic acid, refined[4,10]	1,968,753	2,094,021
Dibutyl phthalate	2,804,827	2,044,675
Dichlorodiphenyltrichloroethane (DDT)	2,331,546	4,092,242
Ethyl acetate (85 percent)	5,260,792	10,185,200
Ethylene glycol	23,007,536	17,554,628
Ethyl ether	2,424,177	4,019,229
Formaldehyde (37 percent by wt.)	53,497,372	46,340,624
Hexachlorocyclohexane	1,217,068	147,833
Methanol, natural[9]	1,455,382	1,467,480
Methanol, synthetic	58,472,357	47,442,143
Naphthalene:		
Tar distillers, less than 79° C.	14,142,778	.....
Tar distillers, 79° C. and over	9,009,500	8,600,728
Coke-oven operators, less than 79° C.	8,531,934	7,266,151
Penicillin and salts[8]	6,601,355	3,130,354
Phenol	25,973,126	19,570,782
Phthalic anhydride	12,433,117	11,687,485
Styrene, government and private plants	26,005,410	38,179,621
Toluene:		
Coke oven operators	2,427,900	2,010,062
All other	3,744,034	2,977,737
Xylene, crude	3,359,083	3,737,720

All data in pounds except benzene (gal.) creosote oil (gal.) toluene (gal.) xylene (gal.) and penicillin (million Oxford units). Statistics collected and compiled by U. S. Tariff Commission except where noted. Absence of data on production indicates either that returns were unavailable or confidential. [1]Excludes the statistics on recovered acid. [2]Acid produced by direct process from wood and from calcium acetate. [3]All acetic anhydride including that from acetic by vapor-phase process. [4]Product of distillers who use purchased coal tar only or from oil-gas or water-gas produced or purchased by tar distillers. [6]Statistics are given in terms of bulk medicinals only. [6]Statistics collected by Bureau of Mines. [7]Total production including data reported both by coke-oven operators and by distillers of purchased coal tar. [8]Reported to U. S. Bureau of the Census. [9]Includes toluene produced from petroleum by any process. [10]Includes refined cresylic acid from petroleum.

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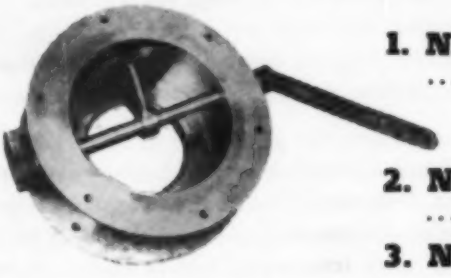

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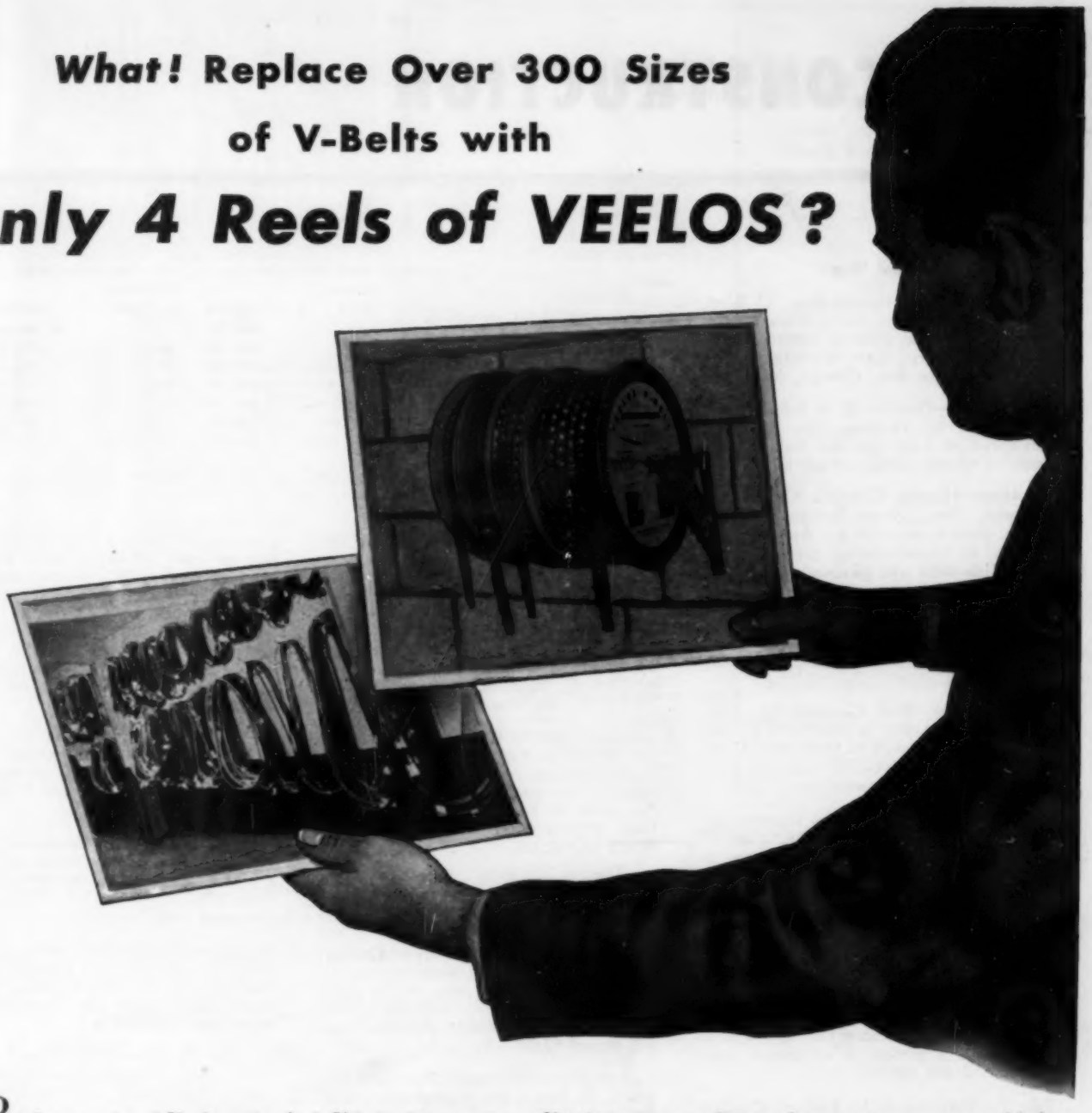

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	Current Projects		Cumulative 1948	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	$68,000	.....	$1,361,000
Middle Atlantic	.....	233,000	$2,276,000	12,379,000
South	$1,250,000	20,815,000	57,285,000	61,044,000
Middle West	800,000	6,066,000	12,650,000	17,388,000
West of Mississippi	3,325,000	7,396,000	113,735,000	23,629,000
Far West	2,500,000	2,575,000	12,150,000	25,279,000
Canada	150,000	9,000,000	30,740,000	20,795,000
Total	$8,025,000	$46,153,000	$228,836,000	$161,875,000

Proposed Work

Ill., Skokie—Portland Cement Assn., 33 West Grand Ave., Chicago, has purchased a 15 acre site here and plans to construct a research laboratory. Carr & Wright, 333 North Michigan Ave., Chicago, Archts.

La., Opelousas—Humble Oil & Refining Co., 1216 Main St., Houston, Tex., has taken an option on a site here and plans to construct a refinery. Estimated cost $1,250,000.

O., Akron—Harwick Chemical Co., C. J. Harwick, Pres., Akron Savings & Loan Bldg., plans to construct a 2 story chemical factory for manufacturing plastics, a research laboratory and warehouse. Estimated cost $300,000.

Tex., Baytown—Humble Oil & Refining Co., 1216 Main St., Houston, plans to construct a pipe still here. Estimated cost $1,500,000.

Tex., Deer Park—Shell Chemical Co., Deer Park, Houston, plans to construct a 1 story, 64x120 ft. addition to its plant here. C. A. Mulvey & Associates, 2621 Caroline Ave., Houston, Engrs. Estimated cost $75,000.

Tex., Fort Worth—Consolidated Chemical Industries, Inc., Old Denton Rd., plans to construct a 1 story, 28x80 ft. addition to its plant. Leonard P. Conley, N. P. Anderson Bldg., Archt. Estimated cost $100,000.

Tex., Houston—St. Joe Paper Co., Clinton Docks, plans to construct a paper box plant on a 38 acre site northwest of here. Estimated cost $1,500,000.

Tex., Mt. Pleasant—Talco Asphalt & Refining Div. of American Liberty Oil Co., plans to reconstruct a portion of its refinery here. Estimated cost $80,000.

Tex., Tex City—Linde Air Products Co., 205 East 42nd St., New York, N. Y., plans to construct a 2 story plant here. Estimated cost $70,000.

Wash., Longview—Pacific Paperboard Co., Longview, plans to construct a newsprint mill. Moore & Co., 450 Mission St., San Francisco, Calif., Cons. Engr. Estimated cost $2,500,000.

B. C., Burnaby — Mainland Clay Products, Ltd., Burnaby, plans to construct an addition to its plant. Estimated cost $150,000.

Contracts Awarded

Ala., Childersburg—American Development Co., c/o contractor, has awarded the contract for a rayon plant to Daniel Construction Co., 822 7th Ave., S., Birmingham. Estimated cost $20,000,000.

Calif., Redwood City—Hodges Research Laboratory, c/o R. Dalton, Engr., 1725 Webster St., Oakland, has awarded the contract for a laboratory to Remmett Construction Co., Box 878, Palo Alto. Estimated cost $75,000.

Del., Henry Clay (Claymont P. O.)—E. I. du Pont de Nemours & Co., Inc., 10th and Orange Sts., Wilmington, has awarded the contract for an ammonia-semi-works, to J. A. Bader & Co., Inc., 923 Market St., Wilmington. Estimated cost $100,000.

Fla., Miami—McKesson & Robbins, Inc., c/o R. Law Weed, Archt., 1527 du Pont Bldg., has awarded the contract for a warehouse to Gust K. Newberg, Construction Co., 7117 N.W. 5th Court, at $414,774.

Ill., Chicago—Peoples Gas Light & Coke Co., 122 South Michigan Ave., has awarded the contract for a battery of 51 byproduct underjet type coke ovens at the Crawford Ave. plant to Koppers Co., Inc., Koppers Bldg., Pittsburgh, Pa. Estimated cost will exceed $3,500,000.

Ill., East St. Louis—Socony Vacuum Oil Co., 26 Bway., New York 4, N. Y., has awarded the contract for modernizing its oil refinery to increase capacity from 21,000 to 30,000 bbl. per day, installing floating roof storage tanks, thermal cracking units, naphtha reforming units, distilling units, etc., on South 20th St., to Bechtel Corp., 220 Montgomery St., San Francisco, Calif. Estimated cost will exceed $2,000,000.

Ind., Fort Wayne—Pittsburgh Plate Glass Co., c/o C. H. Packer, has awarded the contract for a sales building and warehouse to Max Irmscher & Sons, 1113 Fort Wayne Bank Bldg. Estimated cost $150,000.

Ia., Cedar Rapids—Eddy Paper Corp., will construct an industrial building with own forces. Estimated cost $500,000.

Md., Baltimore—Noxzema Chemical Co., 3100 Falls Cliff Rd., has awarded the contract for a 3 story, 80x200 ft. plant addition to Consolidated Engineering Co., 20 East Franklin St.

Mass., New Bedford—Acushnet Process Co., 744 Belleville Ave., has awarded the contract for a 2 story, 50x120 ft. addition to its plant for the manufacture of rubber goods to Olson & Appleby, 222 Union St. Estimated cost $68,000.

Mo., Louisiana—Department of Interior, Bureau of Mines, Washington, D. C., has awarded the contract for the design and construction of a gas synthesis (Fischer-Tropsch process) demonstration plant near here to produce oil from coal to Koppers Co., Inc., Pittsburgh, Pa., at $4,413,250.

O., Cleveland—General Electric Co., Nela Park, has awarded the contract for altering a building to create a chemical plant addition to group of experimental laboratory buildings to Sam W. Emerson Co., 1836 Euclid Ave. Estimated cost $200,000.

O., Cleveland—Harshaw Chemical Co., 1945 East 97th St., has awarded the contract for a 3 story, 31x81 ft. addition to its plant to H. K. Ferguson Co., 1783 East 11th St. Estimated cost $73,000.

O., Fremont—Fremont Rubber Co., Robert P. Johnson, Gen. Mgr., has awarded the contract for an addtiion to its factory to Steinle-Wolfe, Inc., Fremont. Estimated cost $75,000.

Pa., Pittsburgh—Standard Oil Co. of Pennsylvania, 35th St., has awarded the contract for a 2 story, 76x118 ft. laboratory and warehouse to S. M. Siesel Co., 3528 Forbes St. Estimated cost $75,000.

S. C., Anderson—Anderson Industrial Bldgs., Inc., c/o contractor, has awarded the contract for a rayon manufacturing plant to Daniel Construction Co., Greenville. Estimated cost $400,000.

Tex., East Houston—Texas Pipe Line Co., Texas Bldg., Houston, has awarded the contract for a pump house to R. P. Farnsworth Co., Inc., P. O. Box 74, Houston. Estimated cost $78,000.

Tex., Houston—Shell Oil Refinery, Shell Bldg., has awarded the contract for a maintenance shop, shop and warehouse, and change house addition to Harold Van Buskirk & Co., Inc., Southern Standard Bldg. Estimated cost $2,405,000.

Utah, Salt Lake City—Utah Oil Refining Co., Utah Oil Bldg., has awarded the contract for a propane deasphalting plant to M. W. Kellogg Co., 225 Bway., New York, N. Y. Estimated cost $2,500,000.

Wis., Menasha—Marathon Corp., River St., has awarded the contract for a 1 story, 150x200 ft. ink factory to C. R. Meyer Sons Co., 50 State St., Oshkosh.

Ont., Belleville—The Bakelite Co. of Canada, Ltd., 163 Dufferin St., Toronto, has awarded the contract for a plant to Richard & B. A. Ryan, Ltd., 1808 William St., Montreal, Que. Estimated cost $2,000,000.

Ont., Toronto—Lever Bros., Ltd., 229 Eastern Ave., has awarded the contract for plant extensions to Redfern Construction Co., 36 Toronto St. Estimated cost $7,000,000.